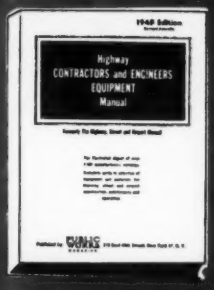
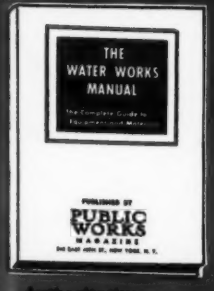
FEBRUARY 1948

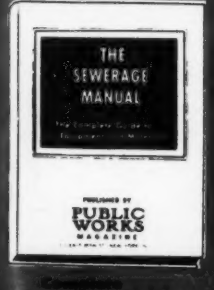
IN THIS ISSUE:
Design in Permafrost
Small Sewage Treatment Plants
Stabilizing Earth Slopes
San Diego Aqueduct

Public Works Magazine

Are You Getting These 4 Benefits from Your Equipment Manuals?







Reports just received from 277 users show Manuals Great Helps

5% of those who received Manuals last December have just reported how they use them. 227 indicated they refer to the Manuals constantly in their work. 163 told of specific cases where they had looked in the Manual first for facts about products they had *specified* or *purchased* from 73 different manufacturers. 228 said they prefer having manufacturers' catalog data bound in the Manual. 27 like individual catalogs better, and 22 said it is handy to have both. This cross-section of opinions proves PUBLIC WORKS' MANUALS to be constantly used by engineers and contractors in getting better equipment, and thus to be of great value to manufacturers, too.

Here are 4 reasons others give why it will pay *you* to use your copies of the Manuals pictured here each time you need data on equipment or materials:

SAVE MANY HOURS WORK

"While the same data might be available from privately assembled catalog data, we find your Manual much more convenient," B. H. & Asso., Cons. Engrs.

HELP EXPLAIN EQUIPMENT TO OTHERS

"It is of great value in explaining equipment and processes to interested laymen," E.R.W., City Engineer.

INSURE YOU DON'T OVERLOOK ANY PRODUCT

"The Manual has the complete story, illustrated and indexed, and all between two covers and that is what we like," F.D.B., Water Supt.

ALWAYS UP TO DATE

"A big advantage is the Manuals are always up to date, while most files contain many obsolete catalogs," J.R.C., Highway Engineer.

The Manuals are complete, authoritative, unbiased. If you cannot locate the one you need right now in your office, write PUBLIC WORKS Magazine, 310 East 45th Street, New York 17, N. Y., and we will let you know at once how you can obtain duplicates.

PUBLIC WORKS Manuals: HIGHWAYS · WATER WORKS · SEWERAGE

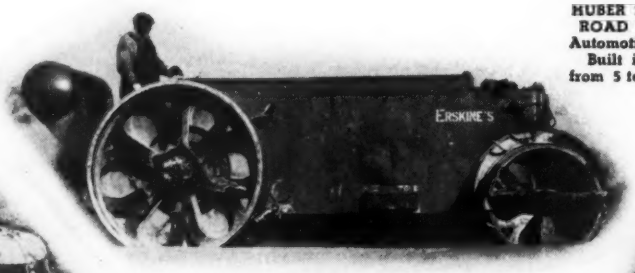
YOU ALWAYS FIND IT IN *The Manual*

HUBER ROAD MACHINERY

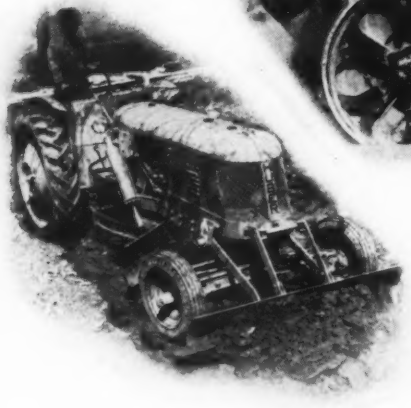
Won't Pull Rabbits out of a Hat . . .

BUT IT WILL PERFORM MIRACLES ON THE JOB

There is no secret behind the low cost operation, dependable performance and long life service of Huber Road Machinery. The answer is – IT IS BUILT FOR THE JOB. The only reason Huber Road Rollers, Tandem Rollers and the Huber Maintainer "performs miracles" on any road construction or maintenance job is because they embody every vital feature that years of experience and "know how" have prescribed as sound. Thus – speed – maneuverability – sturdy construction – simplified controls – fast, smooth operation – accessibility – and many other desirable features are an integral part of every Huber. Consider these things most seriously the next time you buy road machinery. In the meantime, visit your Huber Distributor. He is a good man to know.



HUBER 3-WHEEL ROAD ROLLER
Automotive Type
Built in sizes
from 5 to 12 tons.



THE HUBER MAINTAINER
readily converted into a bulldozer, lift-loader, patch roller, snowplow or rotary broom. A real time and money saver.

HUBER TANDEM ROAD ROLLERS
Variable weight
Built in sizes
from 3 to 12 tons.

THE HUBER MFG. COMPANY • MARION, OHIO, U. S. A.

HUBER

3 Wheel • Tandem

ROAD ROLLERS *and* MAINTAINERS

Vol. 79 PUBLIC WORKS No. 2

Published monthly by PUBLIC WORKS JOURNAL CORPORATION, 310 East 45th St., New York 17, N. Y. Subscription Rates: U. S. A. and Possessions, $3.00. All other countries, $4.00.

FEBRUARY, 1948

NEW ALL THROUGH! FORD *Bonus* Built* TRUCKS

BUILT STRONGER TO LAST LONGER!

NEW FORD BIG JOBS!

F-7 BIG JOB 19,000 LBS. G.V.W.
F-8 BIG JOB 21,500 LBS. G.V.W.

★ ***NEW*** Rouge 337 Truck V-8 engine! 145 horsepower. Hydraulic valve lifters. Cobalt-chrome faced exhaust valves. 4-ring pistons with top ring porous-chrome plated.

★ ***NEW*** Million Dollar cab gives you living room comfort. 3-way air control. Level Action cab suspension.

★ ***NEW*** 5-speed transmission; overdrive-type available in F-8, standard in F-7.

★ ***NEW*** heavy duty Quadrax rear axles. Hypoid-type in F-7, two-speed-type in F-8.

★ ***NEW*** Feather-Foot vacuum-actuated truck brakes. 16-in. by 5-in. double cylinder rear brakes in F-8, 16¼-in. by 3½-in. double action rear brakes in F-7.

★ ***NEW*** roller action steering! 3-tooth roller supported by two rows of needle bearings. Free-moving steering worm rides on two sets of roller bearings.

You'll find these and scores of other outstanding features in the brand new Ford BIG JOBS for '48! They're Bonus Built for wider use, longer life!

Listen to the Ford Theater over NBC stations Sunday afternoons 5:00 to 6:00 p. m., Eastern Standard Time.

Series F-5 illustrated

Bonus Built* — THE AMAZING RESULT OF AN ENGINEERING PRINCIPLE THAT ASSURES WIDER USE, LONGER LIFE . . . and ONLY Ford Trucks have it!

Every one of the new Ford Trucks for '48 is Bonus Built . . . built with *extra strength* in every vital part. This extra strength provides WORK RESERVES that pay off for you in two important ways:

- **FIRST, these WORK RESERVES give Ford Trucks *a greater range of use* by permitting them to handle loads beyond the normal call of duty. Ford Trucks are not limited to doing one single, specific job!**

- **SECOND, those same WORK RESERVES permit Ford Trucks to relax on the job . . . to do their jobs easier, with less strain and less wear. Thus, Ford Trucks *last longer* because they work *easier!***

Yes, Ford Trucks are Bonus Built . . . built stronger to last longer! That's why they give their owners wider use and longer life! That's why there are more Ford Trucks in use today than any other make!

BONUS:** ***"Something given in addition to what is usual or strictly due."
—Webster's Dictionary

THEY'RE here . . . they're revolutionary! The finest line of trucks in Ford history!

More than 139 chassis-body combinations! Three new engines! New Million Dollar Cab! New frames, axles, brakes, steering!

See the new Ford Bonus Built Trucks now. You'll find the *right* truck for your needs in the new Ford line.

LIFE INSURANCE EXPERTS PROVE . . . FORD TRUCKS LAST UP TO 19.6% LONGER!

When you need special information—consult the **ENGINEERS' LIBRARY** *on pages 77-81*

PUBLIC WORKS Magazine

Founded in 1896

Devoted to the interests of the engineers and technical officials of cities, counties and states

Vol. 79, No. 2

W. A. HARDENBERGH and A. PRESCOTT FOLWELL
Editors

FEBRUARY, 1948, CONTENTS

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The Editor's Page

A Birthday Comes to the Dean of Public Works Staff

While this issue was being made ready for the press, on January 15, the staff of PUBLIC WORKS took time off to help A. Prescott Folwell celebrate his eighty-third birthday. The many friends of Mr. Folwell will be glad to know that he is still about as active and agile as he has been for the past twenty-five years; if you are walking with him and lose him in a crowd, always look ahead for him and not behind. An outstanding engineer, his great abilities have been somewhat cloaked by his extreme modesty; a gracious gentleman, he has had a profound influence for the best on the younger engineers with whom he has been associated; a man of great spirit, he did not let the storms of the past month interfere with his attendance at the office—a thing that cannot be said of many of the younger men on the staff. He enters his eighty-fourth year with the deep affection of everyone in this office, and with their hope that his career with PUBLIC WORKS, which began on a full-time basis forty-one years ago last Jan. 1, will long continue.

Lessons From the "Big Snow"

The storm that smothered New York City and the eastern industrial areas under 25 to 30 inches of snow carried an emphatic lesson, which was emphasized still more by the ice and lesser snow storms that followed. This storm proved again how even a minor catastrophe can seriously disrupt the life of a modern community. It wrote in very large letters a warning for more and better planning for emergencies by government. And this means, basically, our municipal governments.

Because at this season of the year, winter storms are very much in the news, we are prone to think and speak of preparedness for such emergencies in terms of more snow plows and more snow removal equipment of modern and up-to-date types. Many of our communities lack these, and need them, but let us look at the overall picture and consider the broader problems, which may be vastly more important than a fall of snow.

The past few years have seen an acceleration of the trend to move into the country, but not so far as to get away from normal city comforts and advantages—light and power, piped water, milk deliveries, the corner grocery, fuel oil for heat, and transportation to and from work. Many of the resulting small communities are not incorporated; in New York State they rely on the antiquated (and pretty much helpless) Town system for government; in other states, the situation is generally not much better. If incorporated, neither government personnel nor equipment are suited for more than the merest routine of ordinary duties.

We can recall no more than one or two of the many recent emergencies where there was any plan or any quick and effective action by any agency charged with responsibility for the protection of the public.

First of all, each community needs a plan, and should have an emergency planning group with the responsibility of anticipating and being ready for emergencies. These community groups should be tied into a larger organization in order to get the benefits of the ideas of others and the advantages of group cooperation. In every group, whether local or general, there must be someone with experience, courage and vision; there must be a place high up on every level for the engineer; there must be a recognition for the need for adequate equipment and supplies.

Here is a big job for someone to plan and organize. Perhaps the Red Cross should take the lead, but it hasn't done so in the past and it seems doubtful if it can or will in the future. It still feels that engineering can be taken or left on a part-time basis, and without adequate and sound engineering advice it cannot get far. So let the Red Cross mop up after the event. The advance doing is up to someone else. Since the health and welfare of the public is the basic problem, this is a real opportunity for the State Sanitary Engineers. There are few other groups in the country that possess as high an aggregate of skill, special training and ability; but they also need aggressiveness over and above what they have shown as a group in the past.

Let's start getting ready. The engineer is the prime factor but it takes community action. Local newspapers may well be a starting point for local action. They are welcome to print any or all of this.

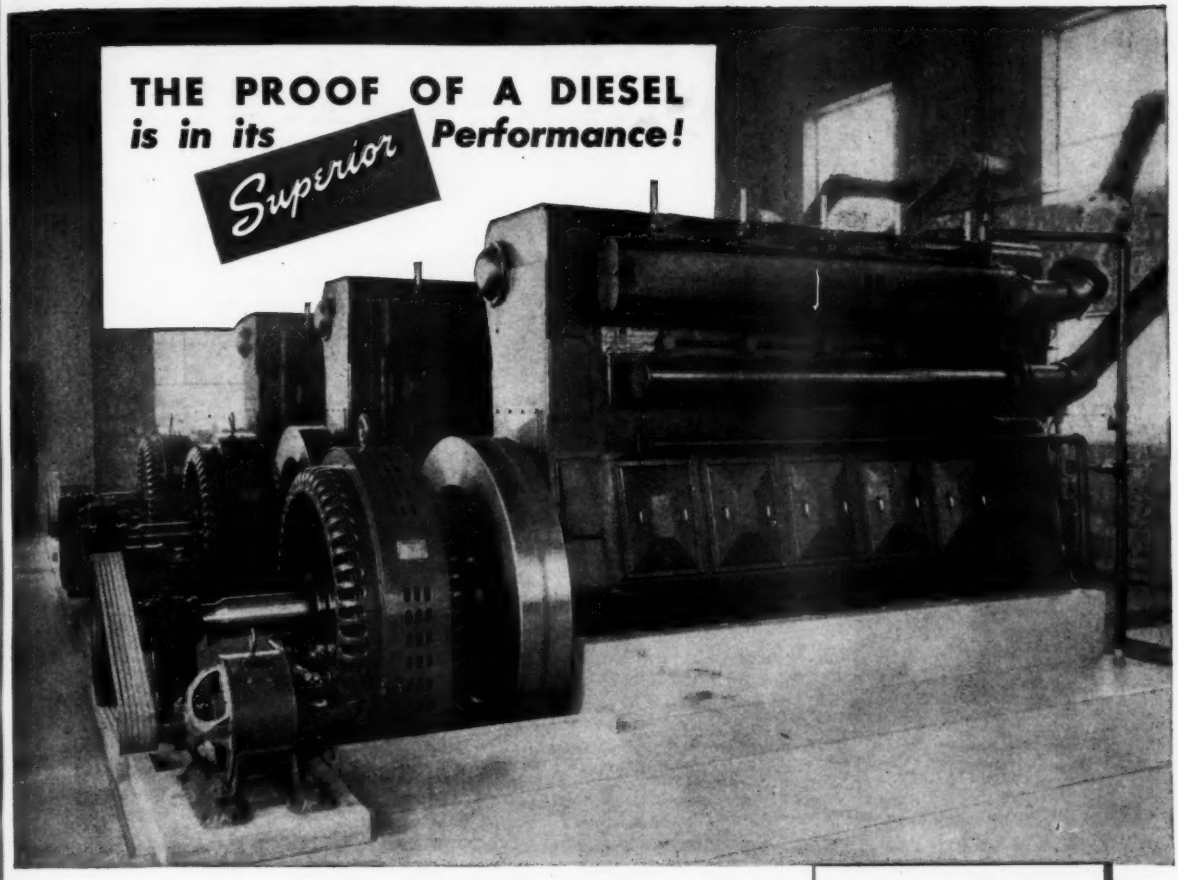
More Public Works Construction in 1948

New public works construction in the United States will be larger in 1948 than it was in 1947, according to estimates of the Federal Works Agency. A volume of public works construction of about $3.7 billion is anticipated, 20% to 25% greater than in 1947. Work financed by Federal funds will aggregate around $1.355 billion, up 15% to 20%. State and locally financed work will total around $2.345 billion. By various FWA estimates, this will be from 25% to 35% higher than last year. The figures quoted are in terms of 1947 dollars and therefore represent a marked increase in the physical volume of the work.

Sufficient materials and labor are, according to the FWA, available to carry on the 1948 program. While there are spot shortages of some items, there is a greater availability of materials and less waiting is in prospect.

The capacity of the country to carry on this volume of work appears to be unquestioned. If the 1948 program is viewed in the light of 1939 costs, the total volume of construction will be about 10% greater than that of 1940. The cost on the basis of percentage of national income is much lower than in the pre-war period. There is no reason why this construction program cannot be carried out. In fact, the outlook for the coming years is very bright.

When you need special information—consult the **ENGINEERS' LIBRARY** *on pages 77-81*

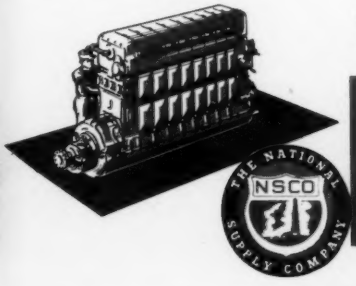


THIS municipal power plant in a Texas town offers convincing proof that Superior Diesels provide complete satisfaction. Originally this plant had three 350 hp. Superior Diesels. On the basis of the performance of these engines, a fourth Superior was purchased one year later; a fifth, six years later; and the sixth, a dual fuel, non-supercharged 720 hp. Superior was added just recently.

Again and again, Superior's on-the-job performance has resulted in repeat orders. These big, husky engines are used for water supply systems, sewage disposal plants, airport lighting and for many other vital municipal services.

Superior Diesels are made in supercharged and non-supercharged models that range from 170 to 1500 horsepower. One of our field engineers will be glad to point out the advantages these engines have for your community.

SUPERIOR ENGINE DIVISION OF
THE NATIONAL SUPPLY COMPANY
Plant and General Sales Office: Springfield, Ohio



Superior DIESEL

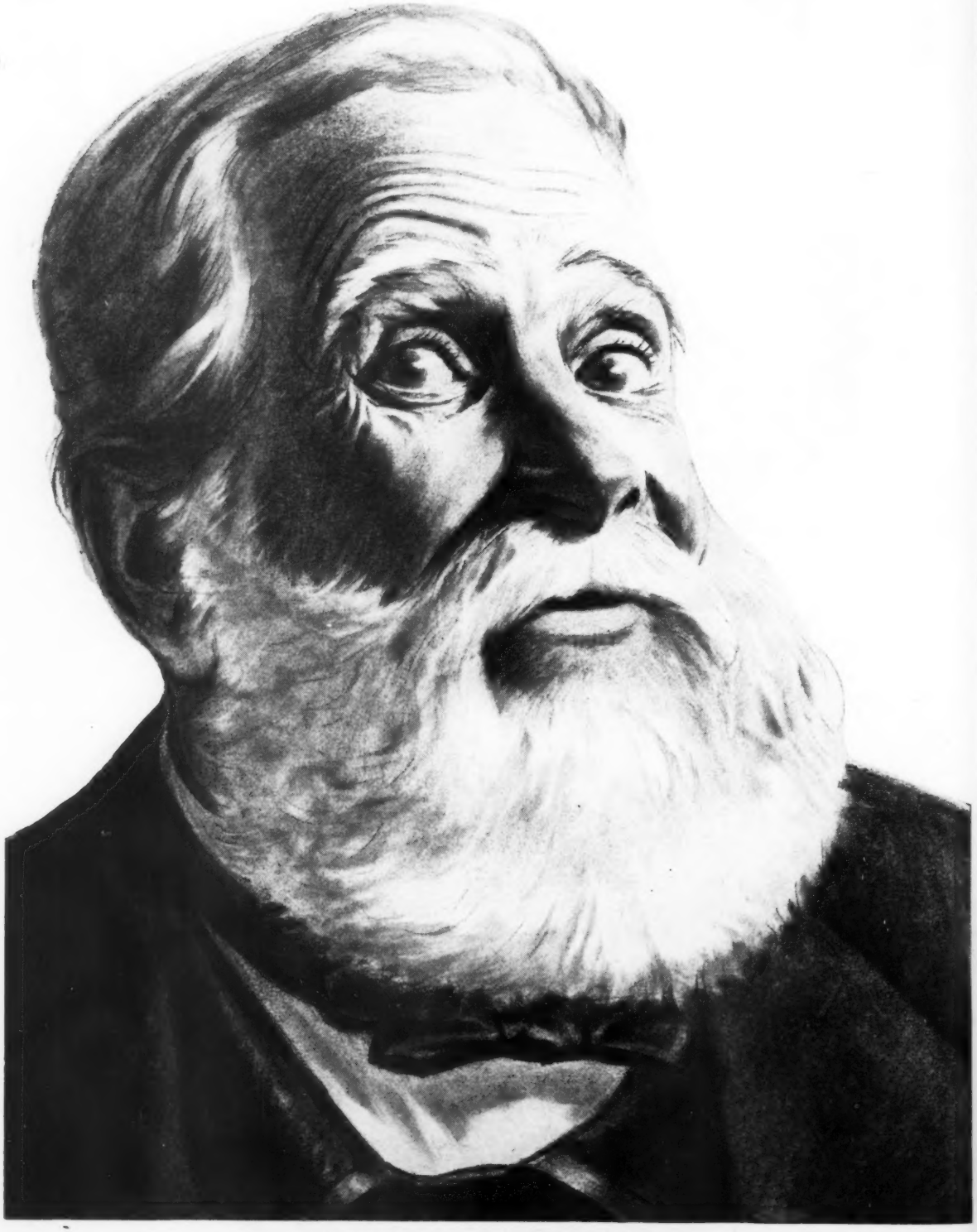
Another Superior Feature

JUST PRESS A BUTTON TO BURN YOUR CHOICE OF FUEL

Superior is the first and only Dual-Fuel Engine with push-button control that permits you to switch from oil to gas; or gas to oil instantly—with the flick of a finger.

Only Superior Diesel Engines Give You Superior Features

"IT TALKS," cried the



When you need special information—consult the **ENGINEERS' LIBRARY** *on pages 77-81*

Emperor of Brazil

AT THE PHILADELPHIA CENTENNIAL EXPOSITION, on June 25, 1876, Dom Pedro, Emperor of Brazil, put his ear to a strange looking gadget. His amazed reaction helped dispel public skepticism about the "gadget"... and the world soon learned to rely upon the *telephone* as a common necessity.

One of the reasons for the rapid success of important inventions such as the telephone is that they were designed and engineered to perform a useful public service.

Transite Pressure Pipe is a more recent example of the same sound principle. It too was designed and engineered to perform a useful public service. In this case, the objective was to transport water more efficiently and economically.

J-M engineers combined asbestos and cement by a special process, produced a material which they called Transite. Transite Pressure Pipe is strong, rustproof, resists even the most corrosive soils ... has a high-flow capacity which can never be reduced by tuberculation.

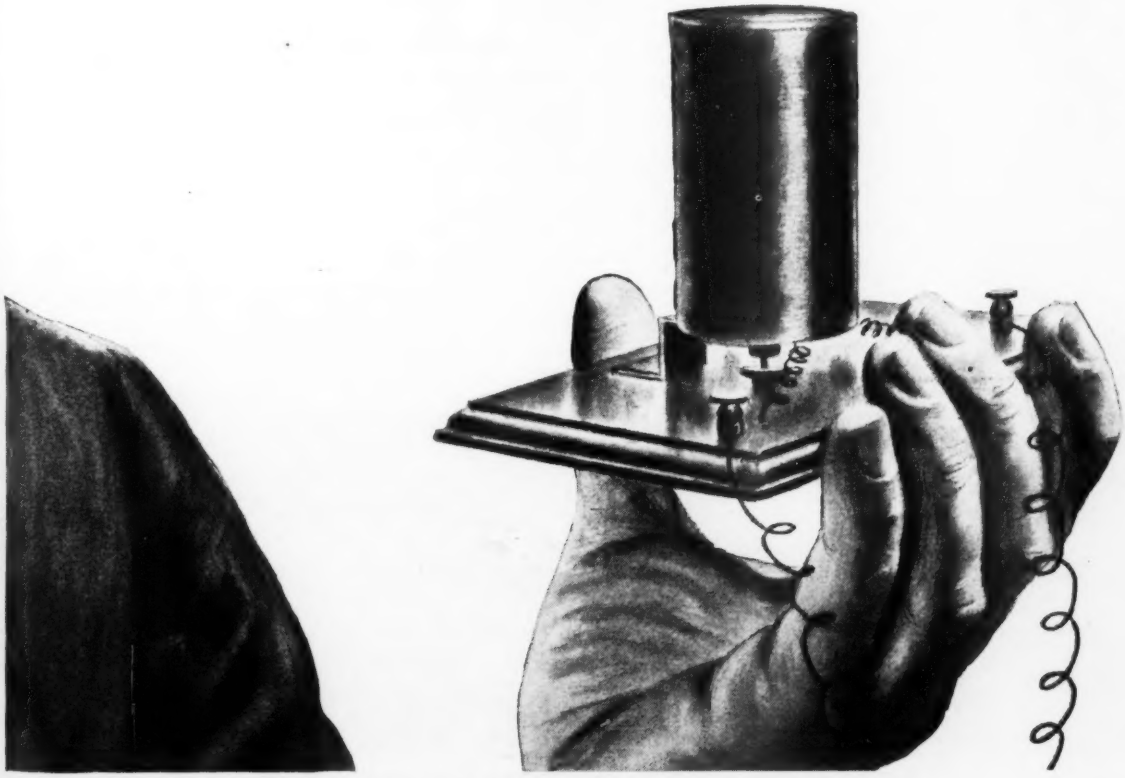
Then a coupling made of Transite was designed and named the Simplex Coupling. Simple and effective, it consists only of a Transite sleeve and two rubber rings tightly compressed into position between sleeve and pipe. This construction guards against leakage and also provides flexibility at each joint. The flexibility helps to cushion the entire line against shock and soil stresses, permits a deflection up to 5 degrees at each joint.

In short, the same kind of engineering foresight and planning that produced the telephone, the steamboat . . . and similar developments which have contributed to industrial progress . . . has been applied to the transportation of water.

Transite Pressure Pipe is now serving the public by delivering clean, healthful water, in abundant quantities, in thousands of communities throughout the nation.

For all the facts about Transite Pressure Pipe, write Johns-Manville, Box 290, New York 16, New York. Ask for Brochure TR-11A.

JOHNS-MANVILLE JM PRODUCTS



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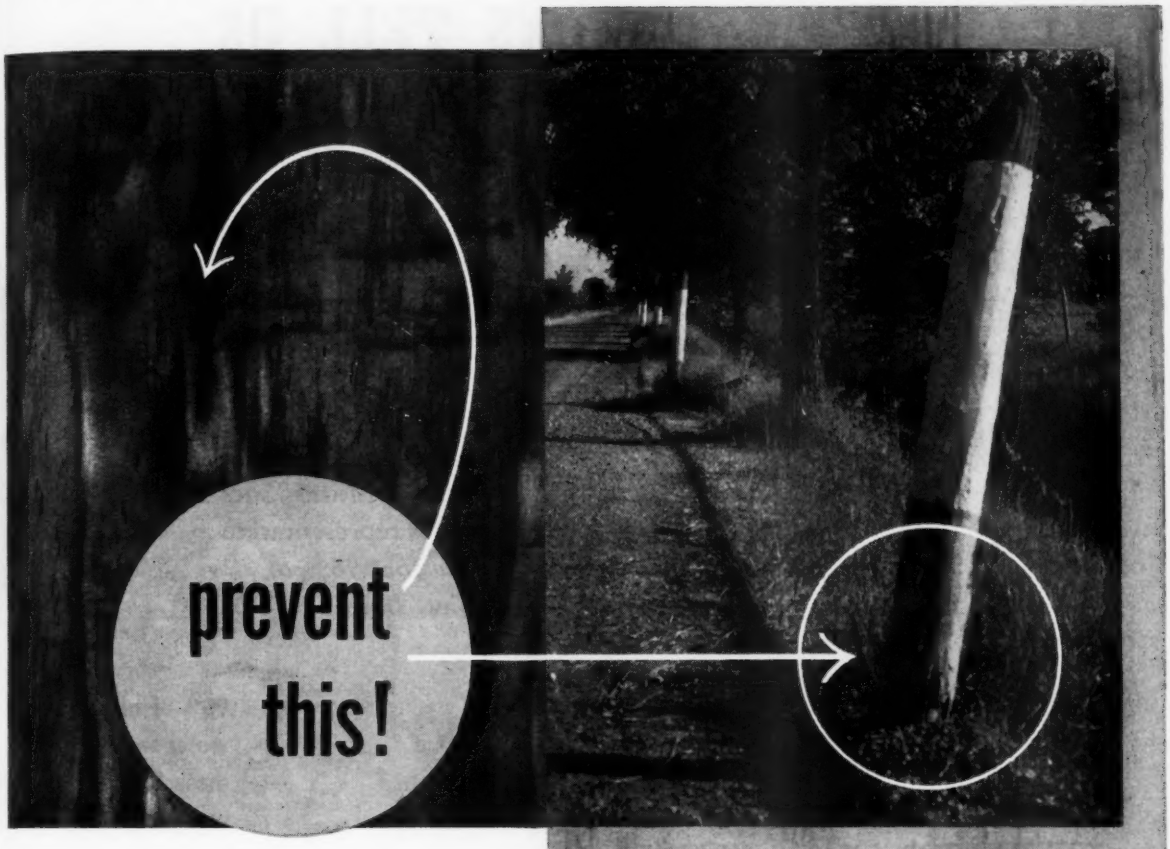


. . . use modern treated wood

By modern treated wood, we mean wood protected with Pentachlorophenol. This proved preservative does more than just prevent costly destruction of wood by decay and termites. Pentachlorophenol is versatile—by proper selection of the oil solvent, it is suitable for the treatment of posts or other wood in contact with the ground, or for roadside furniture and other structures requiring painting.

You will want to specify Pentachlorophenol treated wood. It's a sound investment that pays dividends in reduced maintenance.

Pentachlorophenol is applied to wood at low concentrations in petroleum oils by established pressure and nonpressure treating methods. Pentachlorophenol is available now.

GET THE FACTS. *Send today for this free booklet telling how Pentachlorophenol adds years to the life of wood. Ask for Booklet No. PE 49.*

THE DOW CHEMICAL COMPANY
MIDLAND, MICHIGAN

DECAY
TERMITE
Protected
WITH
PENTACHLOROPHENOL

DOW
CHEMICALS INDISPENSABLE
TO INDUSTRY AND AGRICULTURE

THE CUSTOMERS TELL US HOW GOOD OUR PIPE IS

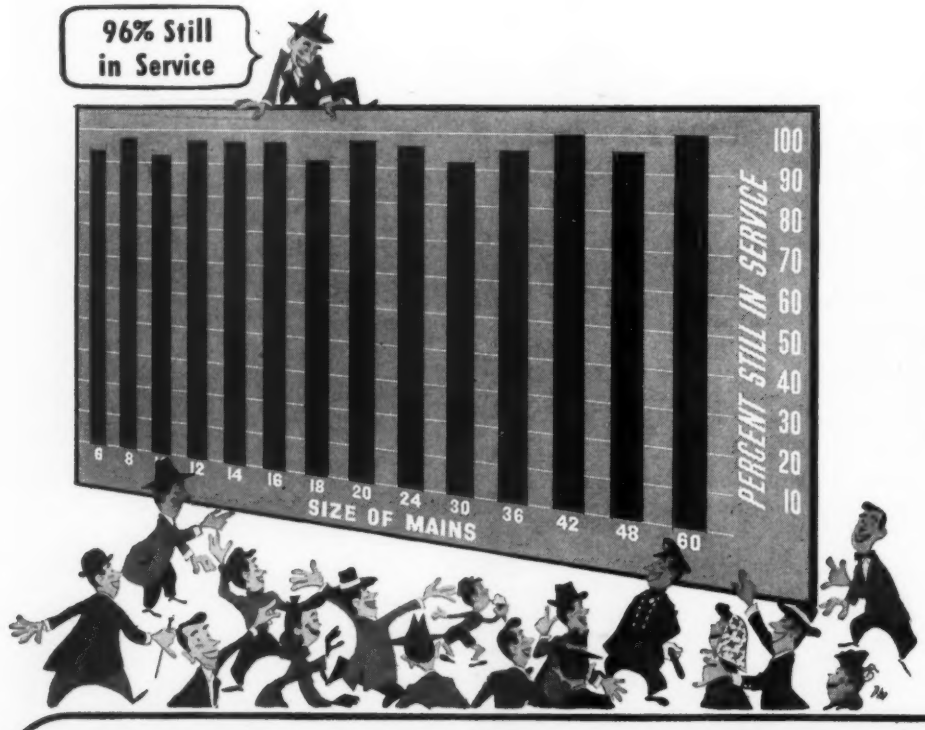
This is a "man bites dog" version of what we have been saying in our advertisements for these many years—namely, that the great majority of the *original* cast iron water mains, laid in this country from the earliest days, are still in service. Now our customers give *us* the facts —facts secured *by* users, *from* users, *for* users.

The chart below is based on a published report of the American Water Works Association of the results of a survey of the "Survival and Retirement of Water Works Facilities" in 25 representative cities. These are facts taken from the records. *They show that 96% of all cast iron water mains ever laid in the 25 surveyed cities, since 1817, in sizes 6-inch and over, are still in service.*

96% of all cast iron water mains* laid in these 25 cities over a period of 128 years is still in service.

Alexandria, Virginia
Babylon, New York
Clinton, Iowa
Clyde, New York
Denver, Colorado
Des Moines, Iowa
Detroit, Michigan
Huntington, West Virginia
Jamaica, New York
Merrick, New York
Norwich, New York
Ottawa, Ontario
Philadelphia, Pennsylvania
Portland, Maine
Rochester (Suburban), N. Y.
St. Mary's, Pennsylvania
St. Paul, Minnesota
Sag Harbor, New York
Scranton, Pennsylvania
Springfield, Massachusetts
Summit, New Jersey
Syracuse (Suburban), N. Y.
Utica, New York
West Palm Beach, Florida
Winnipeg, Manitoba

*Sizes from 6 to 60 inches.



CAST IRON PIPE SERVES FOR CENTURIES

When you need special information—consult the **ENGINEERS' LIBRARY** *on pages 77-81*

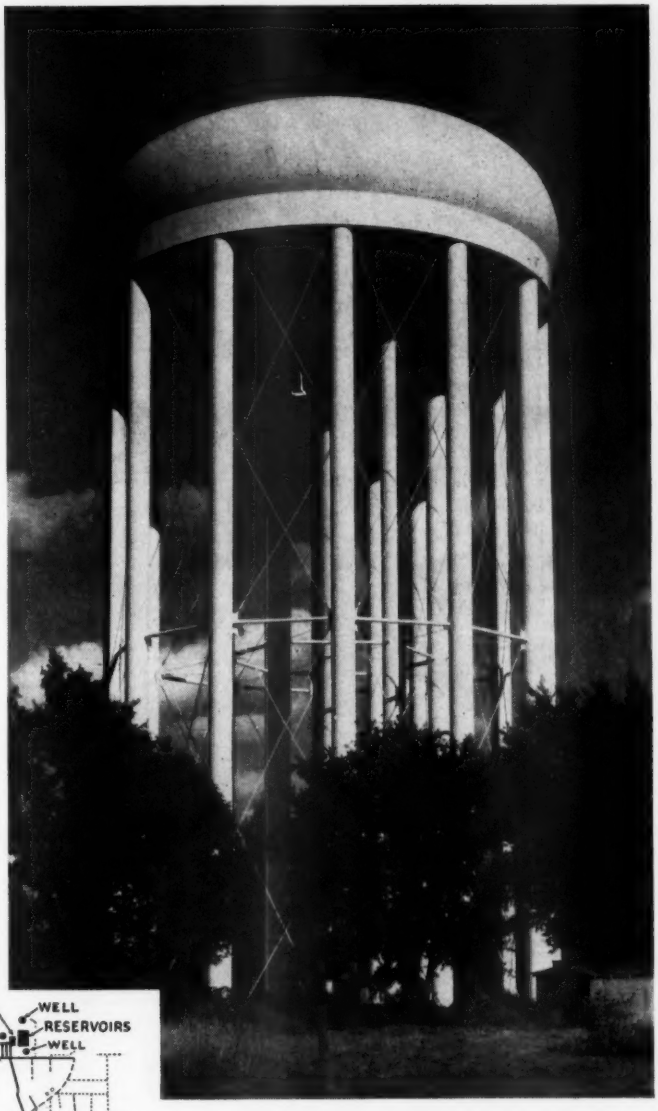
HOW TO *"Ease the Load"* on a municipal power plant

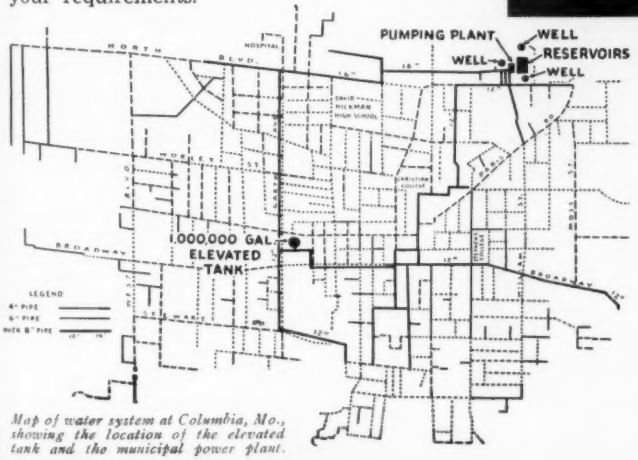
Electricity and steam to operate the deep-well pumps and the high service pumps in the water distribution system at Columbia, Mo., are furnished by the municipally-owned power plant. The 1,000,000-gal. Horton elevated tank shown at the right has a large enough capacity to supply all of the water used for 3 or 4 hours in the evening and the high service pumps can be shut down during the peak load on the power plant. This relieves the demand on the boilers during that period. The tank is refilled at off-peak periods, utilizing surplus power plant capacity with resultant savings in pumping costs.

In addition to "easing the load" on the power plant and improving pressure in the distribution system, the elevated tank provides another benefit for the city. Its installation, together with two new fire stations and several miles of new 12-in. mains, is expected to lower the insurance premiums an estimated $60,000 to $75,000 per year for the residents of Columbia.

Three deep wells ranging from 1200 ft. to 1500 ft. in depth furnish the water for Columbia. It is pumped into underground reservoirs of 4½-million-gallon capacity and then repumped into the distribution system by steam-driven high service pumps.

Quotations on Horton elevated water tanks or Horton steel reservoirs are available upon request. Write our nearest office outlining your requirements.





Map of water system at Columbia, Mo., showing the location of the elevated tank and the municipal power plant.

ENGINEERING DATA

CAPACITY OF TANK.....1,000,000 gallons

HEIGHT TO BOTTOM.....134 feet

DESIGN.....Spheroidal-shaped tank supported on two rings of cylindrical columns with a central riser of the same diameter.

AREA SERVED BY TANK.....Entire city (about two square miles)

DISTRIBUTION MAINS.....60 miles of 4-inch to 6-inch diameter

MAXIMUM DAILY CONSUMPTION.....2,000,000 gallons

MINIMUM DAILY CONSUMPTION.....900,000 gallons

HORTON

STEEL STORAGE TANKS
...for municipal service

CHICAGO BRIDGE & IRON COMPANY

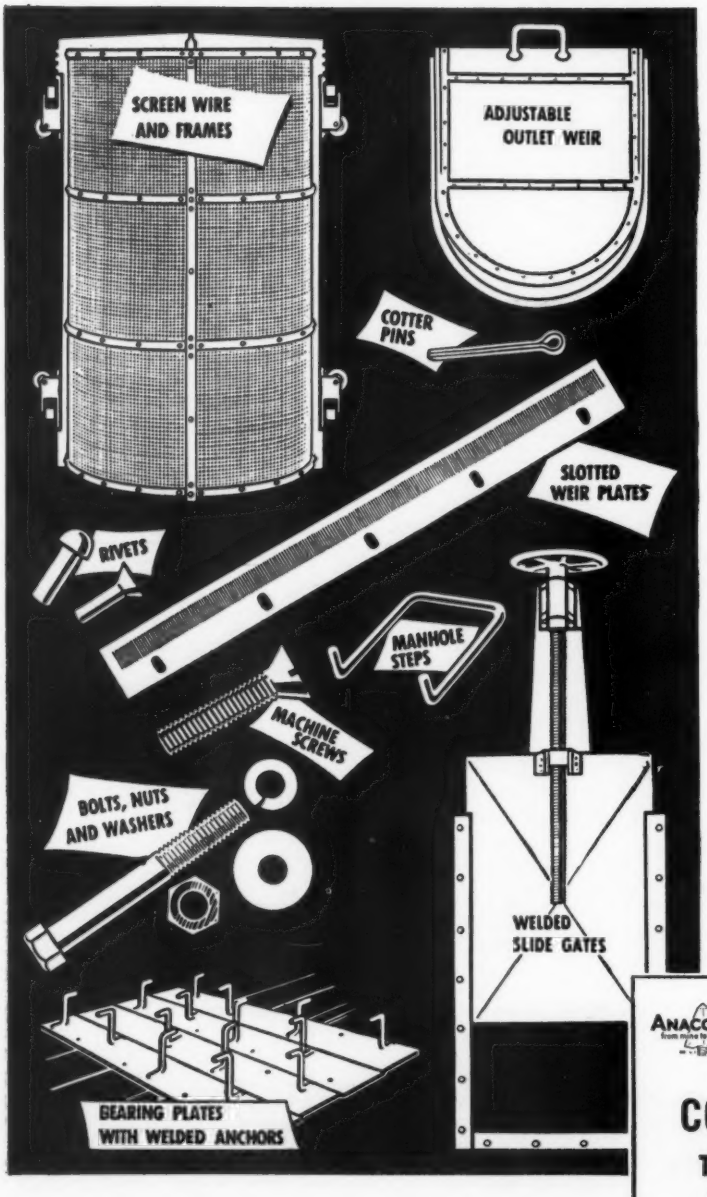
Plants in Birmingham, Chicago, Salt Lake City, and Greenville, Pa.

Chicago 4 . . . . . 2115 McCormick Bldg.
New York 6 . . . 3316-165 Broadway Bldg.
Cleveland 15 . . . . 2221 Guildhall Bldg.
Birmingham 1 . . . 1532 North Fiftieth St.
Tulsa 3 . . . . . 1641 Hunt Bldg.
Houston 2 . . . 2142 National Standard Bldg.
Detroit 26 . . . . . 1536 Lafayette Bldg.
Philadelphia 3, 1648-1700 Walnut Street Bldg.
San Francisco 11, 1255-22 Battery Street Bldg.
Los Angeles 14 . . . 1408 Wm. Fox Bldg.
Atlanta 3 . . . . . 2123 Healey Bldg.
Havana . . . . . 402 Abreu Bldg.

FOR 20 YEARS . . .

the Ideal Metal

FOR SEWAGE TREATMENT WORKS:



Everdur

IN HUNDREDS of sewage and water works installations in the past 20 years Everdur* copper-silicon alloys have given outstanding service under extremely corrosive conditions.

This record is the result of Everdur's remarkable properties. It combines high tensile strength with immunity to rust and excellent corrosion-resistance. Depending on the type or composition, Everdur Alloys may be worked hot or cold, have good machining properties and are readily formed, forged and welded in producing lightweight built-up equipment of exceptional durability.

Everdur is ideal for gates, weir and baffle plates, screens, and many other applications right down to bolts, nuts and cotter pins.

For detailed information, write for Publications E-5 and E-11.

*Reg. U. S. Pat. Off.

ANACONDA from mine to consumer

Everdur

COPPER-SILICON ALLOYS

THE AMERICAN BRASS COMPANY

General Offices: Waterbury 88, Connecticut

Subsidiary of Anaconda Copper Mining Company

In Canada: ANACONDA AMERICAN BRASS LTD.

New Toronto, Ont.

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VOL. 79. NO. 2

Industrial Waste Research

IN ITS report for the 1944-1946 period, which just reached this office, the State Water Commission of Connecticut reported on certain research work on industrial waste disposal. The results of these may be of value in providing leads for other investigative and research work, and are given here, slightly condensed.

Costs of 7 to 15 cents per 1000 gals., or 12 to 25 cents per ton of finished products are indicated by the data reported in this article

Wastes from Felt Making

A large felt manufacturing plant discharges about 300,000 gallons of wastes per day. The raw wastes contain wool grease, soap, sulfuric acid, dyes, sizing materials, and oils used as raw stock lubricants, as well as waste fiber from various felt processing operations. A typical analysis of the raw waste is:

pH	6.8
Total solids	1528 ppm
Volatile solids	464 ppm
Suspended solids	208 ppm
Oxygen consumed	460 ppm
5 day B. O. D.	235 ppm
Sulfate	18 ppm

Simple sedimentation or screening was found to remove most of the suspended material, but there was little change in the volatile solids, oxygen consumed, or B.O.D. Chlorination was helpful in abating odor nuisance and was the cheapest treatment tested, but the actual improvement in the waste beyond abating putrescence was slight. Treatments with from 1½ to 2 pounds of alum or ferric sulfate per thousand gallons, with or without prior treatment with chlorine, showed 70% to 85% reduction in volatile solids and 80% to 96% reduction in oxygen consumed. About 2% sludge developed in one-half hour in these experiments, but some difficulty was encountered with fine suspended material throughout the effluent which filtered readily.

Brass Pickling Wastes

The laboratory has worked out a process of concentrating brass pickling wastes by means of lime precipitation which is believed to be workable, and the next step is to test it under actual plant conditions. Meanwhile, the use of ion-exchange resins offers the possibility of concentrating the waste with simpler and cheaper equipment. The laboratory is unable to evaluate this possibility because there are no data available for the specific conditions. It is proposed therefore, to investigate the effect of flow rates, nature of exchange material, composition and concentration of solution and variations in these latter two factors on the completeness of removal of metals from the liquor and the effect of similar variables on the concentrations obtainable in the regeneration of the material.

Woolen Mill Waste

A small woolen plant, the operations of which consisted largely of washing, stock-dyeing, and piece dyeing, was found to be introducing heavy pollution into a stream. Analyses indicated considerable variation in the comsites discharged. The following represent the rough range of analyses:

pH	7.2 — 8.7.
total solids	1200—5500 ppm
volatile solids	900—1300 ppm
suspended solids	425— 900 ppm
oxygen consumed	1100—1900 ppm
5 day B. O. D.	325— 750 ppm (calculated)

The individual wastes and the various composites were treated in the laboratory with ferrous and ferric sulfates, alum, lime, sulfuric acid, hypochlorites, and chlorinated lime. Various combinations of these chemicals were also used. It was found that the piece dyes wastes could be easily decolorized by chlorination, but treatment of stock dye wastes separately in this manner was not successful. The laboratory recommended finally equalization and treatment of the composites with 2 pounds of alum or ferric sulfate per thousand gallons and the addition of sulfuric acid to give a final pH of 6.5. This required a maximum of 2 pounds of sulfuric acid per thousand gallons of waste. Color was either completely removed or so reduced that it became undetectable in dilutions obtainable in the brook. Reductions in suspended solids varied from 95% to 98%; in volatile solids from 65% to 95%; and in oxygen consumed from 86% to 96%. The effluents were high in total and fixed solids. All analyses of effluents were made after two-hour settling periods. Chlorination after the treatments described did not lead to any further appreciable reduction in color.

With such data available, an economic study for comparison of the two processes will be made. M. G. Burford is supervisor of the laboratory.

Results Accomplished

A paper manufacturing company by the addition of alum and sedimentation is treating its wastes satisfactorily for discharge into a small brook, at an expense of seven cents per 1,000 gallons.

Equally satisfactory results are achieved with simple sedimentation by a company making a different type of paper product, at a cost of twelve cents per ton of finished goods.

Another paper-making concern completed arrangements this year to abate pollution which had been the source of much complaint. Even at today's prices for construction and equipment, the total cost of amortization, interest and operation of settling equipment amounts to approximately twenty-five cents per ton of product.

Abatement of pollution from a laundry created continuing public appreciation and good will at a cost of fifteen cents per 1,000 gallons.

The cost of treating the wastes of a woolen finishing company by chemical precipitation is estimated at less than one-half of one per cent of the sale price of the cloth.

Twenty-six cents per ton of product is the cost of chemically treating the waste from another textile mill.

An iron fabricating concern by chemical precipitation is protecting a fine stream at an expense of twenty-five cents per 1,000 gallons of waste water.

Treatment of wastes from all the major industries in one city, as a cooperative enterprise, can be carried out at a cost of fifteen cents per 1,000 gallons, an infinitesimal part of the value of the goods produced.

Stabilizing Earth Slopes by

Boring Horizontal Drains

This paper, prepared for presentation at the Second International Conference on Soil Mechanics to be held in the Hague, Netherlands, in the summer of 1948, is published in cooperation with California Highways and Public Works.

THOS. E. STANTON

Materials & Research Engineer, California Division of Highways

CONSTRUCTION and maintenance of highways in hilly and mountainous regions is frequently complicated by the activity of old landslides and by the development of new mass ground movements in unstable material during and following construction.

The presence of ground water is the most important factor influencing the development of slides and embankment slipouts. Subsurface water reduces the stability of cut slopes and foundations under embankments through saturation of the soil, thereby diminishing the shear resistance. The weight of the ground mass constitutes a driving force tending to cause slide movements, particularly where hydrostatic pressures are induced in impounded ground water, thereby adding to the driving force. The earth masses may contain strata of plastic material with an unfavorable dip. Lubrication of this plastic material by subsurface water may result in sliding along such a zone. The stratum or zone along which the sliding occurs is described as a "slip-plane."

Methods of Correction

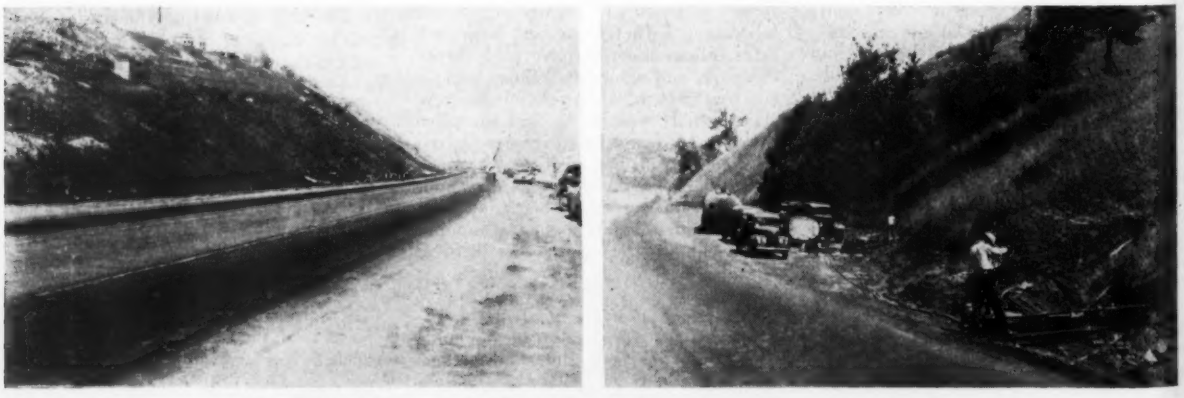
When unstable areas cannot be avoided the structural design of the highway must embody the necessary corrective treatment. Embankment foundations may be stabilized by drainage trenches, vertical sand drains, or pervious blankets, and cut slopes may be stabilized by benching, slope flattening or unloading. However, where slipouts of previously constructed embankments or cut slopes occur subdrainage of the slide mass is more difficult. Excavation of drainage trenches through slipouts is usually very costly and experience shows that deep cut-off trenches above the slipout are often not effective. Slides in roadway cuts are also frequently costly to correct by the usual method of unloading and slope flattening.

In recognition of the need for some more economical and effective method of stabilizing landslides through subdrainage, the California Division of Highways in 1939 undertook to correct such conditions through the installation of perforated metal pipe drains in horizontal or slightly inclined holes. "Hydrauger" equipment was adopted for drilling the holes and is still being used, although numerous improvements have been developed in both the procedure and equipment. In general, the tentative locations, lengths, and required number of drains are determined by a preliminary investigation consisting of vertical test borings and a geological survey. The final locations and lengths of drains are determined by conditions encountered during the installation.

Since the first horizontal drain treatment of unstable areas in 1939, a total of 53 slides and slipouts on the State Highway System have been treated in this manner. Approximately 1150 horizontal drains have been installed with six State-owned hydrauger machines, the total length of drains aggregating over 130,000 lineal feet. The horizontal drain installations are functioning satisfactorily with very little maintenance and, in general have proven very effective in stabilizing the treated areas, although occasional cleaning of the first 15 to 20 feet of the drains has been required in some cases to remove matted root growth entering through the perforations. In future installations it is planned to substitute solid pipe for the perforated pipe in portions of the drains near the surface where root growth can be anticipated.

General Procedure

As a result of eight years of experience with this method of treating unstable areas, a general procedure has been developed. When a slide or slipout occurs, a preliminary investigation is made including foundation studies with vertical test borings and a geological survey to determine the structural composition of the mass and the cause, extent and direction of the movement. When the investigation indicates that improved surface drainage facilities alone will not eliminate the disruptive effects of subsurface water



Left, repairing the Grapevine Slide; right, two Hydrauger units drilling at Cuesta Grade.

without large scale excavation of drainage trenches, unloading or slope flattening, the installation of horizontal drains is usually adopted as the most economical method of correction. Tentative locations, lengths and number of drains required to drain the area effectively are estimated during the preliminary investigation of the probable ground water table, permeability of the material to be drained and location of water bearing strata supplying the reservoirs of impounded ground water. The final locations and lengths of drains are determined by conditions encountered as the job progresses.

Experience has shown that a modified procedure, utilizing vertical sand drains in conjunction with the horizontal drains, is very effective for draining highly stratified areas composed of flat lying sedimentary deposits interbedded with plastic clay. The vertical drains perforate the impermeable clay layers, releasing ground water from the uper portions of the mass to the horizontal drains.

Method of Installation

The horizontal drainage treatment of slides and slipouts by the hydrauger method is conducted by a traveling drill crew assisted by men from the local District Maintenance Stations. All of the equipment normally required for the work is carried by the traveling crew, with the exception of the perforated metal pipe which is stockpiled at convenient locations throughout the State.

The first operation consists of clearing or benching to accommodate the drill equipment at the tentative locations proposed as outlets for the drains, and establishing water and compressed air supply to the hydrauger units which utilize air motors for power and water for washing the hole and cooling the bit. Whenever possible, local water from springs, small streams, etc., is utilized, but on some occasions it is necessary to haul water in tank trucks. An air compressor and water tank are placed at convenient locations, and pipe lines of the proper size are laid to the job site with take-offs at the proposed drilling locations. The size of pipe which is dependent on the pressure and volume of air and water required by the units and the distance transmitted, normally varies between 1½" and 3". The volume of water and air used per drilling unit varies with different types of material and formations which may be encountered, and air consumption is also affected by the elevation above sea level at which the units are operated. On the average job, a 120 c.f. compressor is used per unit and 4000 gals. of water is consumed in 8 hours.

After the air and water supply lines have been constructed, the track is set up at the proposed location and adjusted for the proper slope and direction of the hole. The hydrauger is then placed on the track, connected to the water and air lines with flexible rubber hoses and the drilling started.

A 4" auger type bit is started in the hole, and water is pumped through the hollow diamond drill "A" rod as the air motor revolves the drill in a clockwise direction. The bit is then advanced into the hole by a ratchet frame device mounted on the air motor. Additional drill rods, in five-foot lengths, are added as the drilling proceeds.

Casing the Hole

When the desired depth of hole has been reached, the drill rod is backed out and the hole is ready for the installation of the perforated casing. The air motor is replaced by a ratchet type jack, and the casing is jacked into the hole. The sections of 2" perforated metal pipe, used for casing the holes, are approximately 21 ft. in length. They are butt welded, as the casing operation proceeds, to form a continuous drain for the entire length of the hole. The casing, which is perforated on three-quarter points, is usually installed with the perforations placed up in order to carry seepage water past cracks and fissures in the slide area; however, through sandy strata it is often advantageous to place the perforations down to prevent silting and blocking of the drain. When all of the drilling and casing operations have been completed, the individual drains are tied into a larger common drain, and led to culverts or other disposal areas out of the slide area.

Since the first horizontal drainage system was installed in 1939 numerous changes in the drilling technique have been made. New drilling tools have been evolved for work in different types of formations, and other changes are contemplated as the necessity arises.

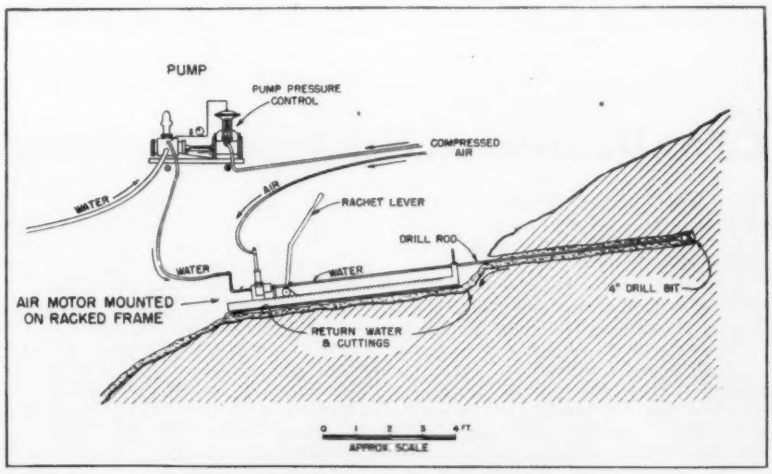
In the original outfit the hole was drilled with a 2½" pilot bit followed by a 4" reamer. Experience showed that the holes could be drilled with less difficulty by substituting a 4" auger bit for the pilot, and eliminating the cumbersome reamers, which often wedge in a hole constricted by movement of the unstable mass. A set of reamers is still carried as standard equipment, but are used only where a hole greater than 4" diameter is desired.

6000 gals. per hr. from a horizontal drain.

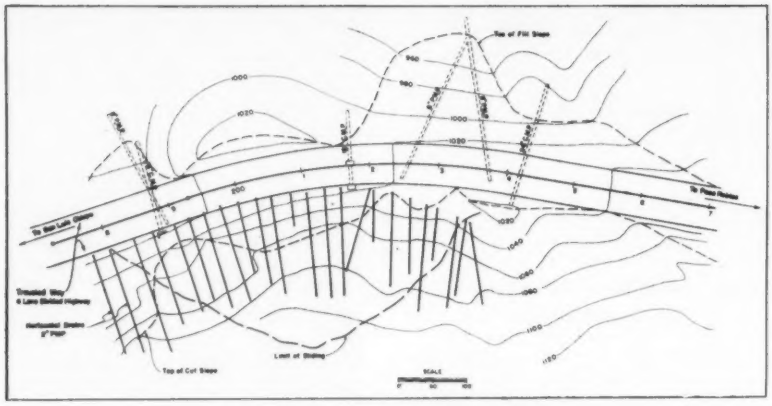
The standard 4" auger bit has been greatly improved by installing a carbaloy insert in the lead point, and by facing the sharp cutting edges with tube borium or other hard materials. Hard, dry, clayey shales and soft sandstones, which stopped the older type bit, are easily drilled with the improved bit.

Special rock-type auger bits with seven carbaloy insets in the lead and cutting surfaces of the bit are being used for drilling in shale, sandstone and partially decomposed granite. At Camp Tejon in Kern County, three holes were recently drilled in partially decomposed granite with this special rock bit, to an average depth of 122 ft. Several years earlier when this same slide area was drilled with the older type bit, the greatest depth attained was 80 ft.

The presence of hard float rock and conglomerate in some slide areas has seriously handicapped drilling operations when using any of the auger type



Typical set-up for drilling horizontal drains.



Drain installation at the Cuesta Grade.

bits. Recently, this department acquired several standard diamond bits and core barrels for use in conjunction with the hydrauger equipment for drilling through hard rock. Experimental drilling with this equipment has shown very satisfactory results although the unit cost for core drilling is considerably higher than when auger bits are used, as the tools must be withdrawn each time a 10 ft. core is taken. Therefore, the horizontal holes are usually started using the auger bit and when hard rock is encountered, the diamond bit and core barrel are substituted for the auger bit. After cutting through the rock and pulling the core, the drilling is resumed with the auger bit.

A modified fish-tail type bit has been used occasionally in sandstone and shale strata. Although this type of bit cuts fairly fast, directional control is difficult for any considerable length, and the use of this new type bit for the entire length of the hole has not been satisfactory.

As most of the locations where horizontal drains are installed are in active slide areas where the ground is in a saturated unstable condition, some difficulty has been encountered in casing the holes after they have been drilled. By using a folding-type bit and a double track set-up, it is often possible to drill and case the holes in one operation. The drill rod is run through the 2" perforated casing with a 4" folding bit immediately ahead of the end of the casing. The drill and casing are moved ahead together to the required depth of hole. The drill rod is then backed out, collapsing or folding the bit and drawing it out through the casing.

In some localities, firm material is encountered at the start of the hole with saturated free-running sand or silt layers near the end of the hole. When this condition is met, the practice has been to jack the casing as far as possible and then to jet through the sand layer.

One of the greatest difficulties that we have had installing horizontal drains have been in holes where loose rock or broken shale strata have been intercepted. The loose rock falls into the hole, and due to the action of the bit, the rock is rolled around in the hole and not drilled. Under such conditions extreme care is necessary to keep the drilled hole straight, and in order to install the perforated casing the loose rock must be removed from the hole. Working in this type of material is difficult and often costly, but it is believed that much of the trouble could be eliminated by circulating a heavy mud under pressure through the hole instead of water, as is normally done.

Court Decision on Mill Waste Discharge

THE Supreme Judicial Court of Maine in Equity has rendered a decision in a case against certain paper companies discharging sulphite waste liquor into the Androscoggin River, and has established specific procedures and standards. The decision, in part, follows:

(1) Beginning with the first week of May, 1948, and continuing through the months of May to September, inclusive, of each year thereafter, until further order of the court, the defendants will maintain weekly sampling and analyses of the Androscoggin River water at North Turner Bridge, and elsewhere as may be necessary to permit the determination of the effect, of the controlled discharge of waste sulphite liquors and other alleged polluting materials into the Androscoggin River, upon the sanitary condition of the river, with particular reference to the production of obnoxious odors and fumes. The sampling and analyses shall conform to methods and procedures acceptable to the Attorney General and the data thus obtained, together with the records of mill production, shall be made available to the Attorney General. The sampling and analyses shall particularly be directed to the accumulation of data as to the quantities of dissolved oxygen and hydrogen sulphide present in the waters of the Androscoggin at these points.

(2) Brown Company shall provide that its discharge of sulphite waste liquor into the Androscoggin River shall not, during the period from June 15 to September 15, exceed an average of the effluent resulting from the manufacture of 1,540 tons per week; provided that Brown Company shall have the right to discharge up to, but not exceeding, the effluent from 1,750 tons in any week or weeks during such period so long as the average for the entire period does not exceed 1,540 tons per week.

(3) Oxford Paper Company shall provide that its discharge of sulphite waste liquor into the Androscoggin River shall not, during the period from June 15 to September 15, exceed an average of the effluent resulting from the manufacture of 1,330 tons per week during each consecutive four weeks; provided that Oxford Paper Company shall have the right to discharge up to but not exceeding the effluent from 1,500 tons in any week or weeks during such period so long as the average for each consecutive four weeks of such period does not exceed 1,330 tons per week.

(4) The defendants shall install, as soon as practicable and in any event by June 15, 1948, a lagoon having a capacity of approximately 22,000,000 gallons and designed to impound the sulphite waste liquor resulting from the manufacture of at least 400 tons of finished sulphite pulp per week from the Livermore Falls Mill of the International Paper Company (the normal capacity of which is 500 tons per week) during the periods of each year beginning June 15 and ending September 15.

(5) Dr. Walter A. Lawrance of Lewiston, Maine, is designated to supervise and direct the testing, sampling and analyses provided for in this decree and shall be entitled to receive his compensation for services and expenses from the defendants.

(6) If at any time during the period of each year beginning June 15 and ending September 15, Mr. Lawrance shall, in his judgment, decide that the dissolved oxygen content of the Androscoggin River at North Turner Bridge is in danger of falling below four parts per million of dissolved oxygen, he shall direct what portion of the effluent shall be deposited in the lagoon and what portion, if any, shall be discharged into the river; and shall also direct when the lagooned effluent shall be released into the river, using his best judgment to control operation so that the four parts per million of dissolved oxygen may be maintained.

(7) If the defendants shall fail to complete the lagoon by June 15, 1948, or if the lagoon shall fail effectively to retain the waste sulphite liquors deposited therein alternative measures to compensate for any such failure must be provided.

The San Diego Aqueduct

Colorado River water is brought to a fast-growing city despite engineering and political difficulties.

JOHN BEACH

Photos courtesy U.S.N.

A portion of the aqueduct.

THE San Diego Aqueduct was completed December 11, 1947, to carry Colorado River water to semi-arid San Diego county in time to avoid a disastrous drought. Regarded as one of the country's most vitally-needed engineering projects, it is understandable why the citizens of San Diego took the day off to celebrate. Engineers, contractors and public officials concerned with the project joined in the celebration.

Reservoirs of the city, which were ample to supply the prewar population of the city, were virtually empty. This possible shortage was anticipated during the war. Since the city had become one of the most important Navy centers, as well as a vital aircraft manufacturing area, assurance of an ample water supply became a matter of national defense. The Bureau of Reclamation was asked in September, 1944, to make a study of two possible routes for an aqueduct to tap Colorado River water, the only possible source of water supply. One way was to connect with the Metropolitan Aqueduct, serving the Los Angeles area, and the other was to take water from the All-American Canal.

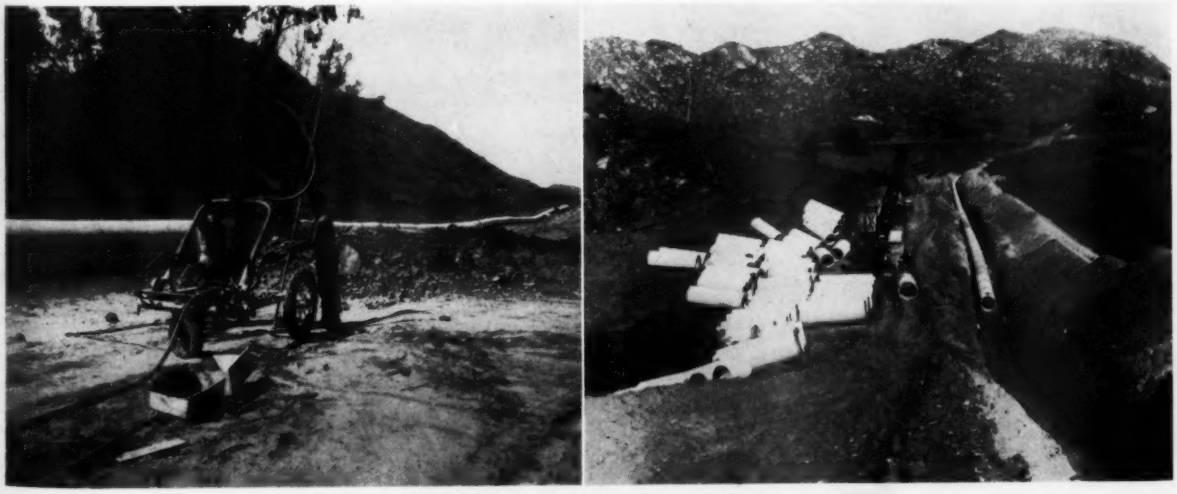
The route via Metropolitan Aqueduct was considered more advisable because it would be a gravity system requiring the minimum amount of critical materials and could be completed in two years. This recommendation was made, the report was approved and the Bureau of Reclamation was ordered to prepare plans in November, 1944, while the Bureau of Yards and Docks, Navy Department, was designated to supervise the construction.

Design Factors

The aqueduct was designed to carry half the amount of the 112,000 acre-feet yearly storage in Lake Mead, which has been allocated to the City of San Diego. The seven tunnels of the line, however, were designed and built to carry the full allocation of approximately 100,000,000 gallons a day.

The Bureau's plans called for a 71.1-mile aqueduct connecting with the Metropolitan at San Jacinto and extending to San Diego's San Vicente Reservoir. The cost was estimated at $14,000,000. The aqueduct plans included 149,152 feet of 48-inch reinforced concrete pipe; 115,088 feet of 54-inch; 64,208 feet of 72-inch; and 9,840 feet of 96-inch reinforced concrete pipe. Steel pipe, 48-inch diameter, was specified where operating heads are between 500 ft. and the 930-ft. maximum. Plate thicknesses on the steel pipe ranged from 7/16 to 13/16 inch. The seven tunnels vary in length from 500 feet to over one mile. The project also includes a 1400-acre-foot earthfill reservoir located two miles south of the junction point with the Metropolitan Aqueduct.

The Bureau had completed plans for the first portion of this work in time for the Navy to open bids on three of the tunnels in April, 1945. Bids for the last section of the work were opened in October, 1945. The contractors were: S. A. Healy Company, which subcontracted the work to J. S. Barrett Company, for four concrete-lined, 6-foot diameter tunnels totalling 11,843 feet, at $789,000; W. E. Callahan Company and Gunther and Shirley Company for three tunnels totalling 11,335 feet, at $848,000; Haddock Engineers, Ltd., for the steel pipe portions of the line at $706,649, the pipe being furnished by Western Pipe and Steel Company; reservoir and connecting pipe line with structures, control gates, etc., to Guy



Construction views on the San Diego aqueduct line.

F. Atkinson Company, at $1,169,681, the concrete pipe being furnished by American Pipe and Construction Company; 21.9 miles of line from the reservoir to Concrete Pipe Constructors, at $2,232,000, the pipe being made and laid by United Concrete Pipe Company; the next 24.9 miles of line to United Concrete Pipe Company at $3,580,000; and the balance of the line, except tunnels and steel pipe sections, to S. A. Healy Company, which also subcontracted this work to J. S. Barrett and Company, at $2,618,000, the concrete pipe being furnished by American Pipe and Construction Company.

Troubles Getting Started

Troubles beset the project. The War Production Board protested that the project would consume manpower and materials and, at the time first bids were called, asked for a year's delay, but the objection was overcome. Then, as construction was getting underway, came V-J Day. The war over, the Government terminated its contract but San Diego city authorities took steps to insure the needed water supply by executing a contract with the Navy to continue construction with the city repaying the actual cost over a period of years. The work continued.

The regulating reservoir near the Metropolitan Aqueduct connection was necessary because the minimum capacity of the Metropolitan District's pumps is 200 cfs., while the San Diego aqueduct was designed for 85 cfs. A 200-cfs. feeder line was built from San Jacinto to the reservoir. The diversion structure at the San Jacinto junction has control gates, a venturi section, measuring and recording instruments; and operator's house.

At the present time, the Metropolitan District pumping system operates intermittently, but eventually it will operate continuously. When regular operation is in progress, the regulating reservoir no longer will be necessary to the San Diego system.

Water leaves the regulating reservoir through a 72-inch precast concrete pipe conduit which reduces to 54 inches and 48 inches according to the grade. The pipe was manufactured in 16-foot sections and hauled to location by trucks and trailers. One of the manufacturers, United Concrete Pipe Corp., had a fleet of 200 trailers in operation at one time for delivering the sections from plant to job. To get the strong, smooth pipe wanted, the Navy specified that the concrete be consolidated by air vibrators rather than the conventional rodding method.

Building the Pipe Lines

The average depth of trenching for the pipe was 12 feet while the maximum depth for 72-inch pipe reached 32 feet. The excavation, which amounted to 2,850,000 cu. yds., usually was done with 1½ and 2½-yd. backhoes. The pipe hauling was done with 30-ton, 20-foot crawler cranes.

Extremely high compaction of 98% was required around the pipe to assure full load carrying. Contractors at first used pneumatic paving breakers for this work, but later found that lighter weight air hammers were most effective in meeting the exacting backfill specifications. A field laboratory was set up to take continuous check on the work of consolidating the moisture controlled material to the specified density. In sandy regions where water was available, density was obtained by a jetted backfill vibrated with concrete vibrators.

The backfilling above the compacted areas employed such equipment as 1½-yd. draglines, bulldozers, carryalls, road graders, sheepsfoot rollers, weighted lumber carriers and tampers for puddling in layers. The project required 114,500 cu. yds. of compacted backfill and 2,100,000 cu. yds. of backfill.

The aqueduct work was carried on areas so remote that two-way radio was the only means of communication. The Navy had a 50-w station at its Vista, California, field headquarters, while its field engineers were equipped with vehicles having 25-w mobile stations. Two of the contractors on the project also installed their own radio communication systems. In all cases, the improved communications facilitated construction through better coordination and in obtaining quick assistance in case of emergencies.

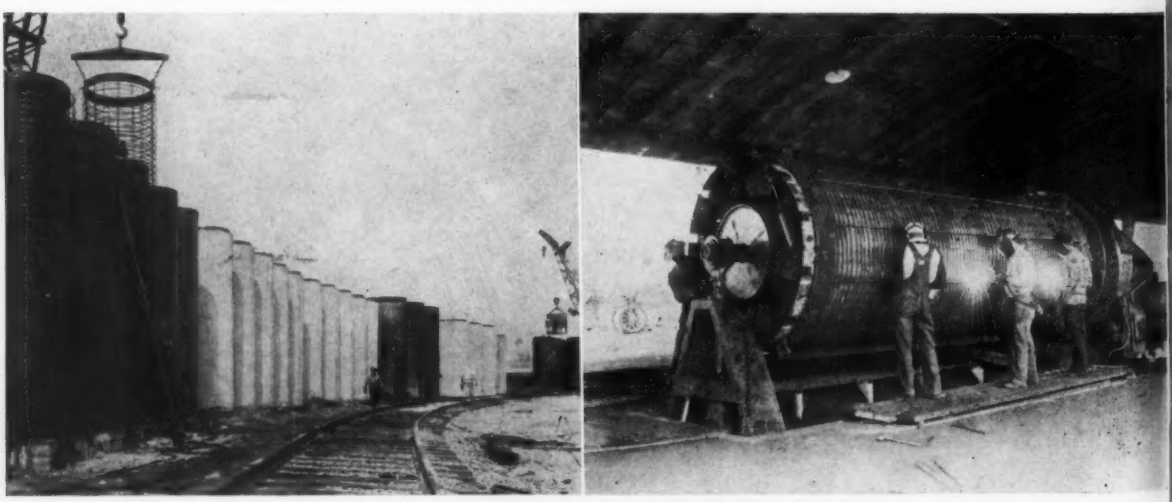
The area through which the aqueduct passes is not only remote, but much of it is rugged. Wagon drills, capable of drilling to a depth of 30 ft., were generally used to expedite the rock drilling work, as they were faster than hand-held pneumatic drills, less tiring and more accurately controlled. Boulders encountered were punched with hand drills and blasted.

Steel Pipe Laying

The steel pipe was fabricated in 30-ft. sections, shop tested and delivered to the site by truck. The 48-inch dia. pipe ranged in thickness from 7/16-inch to 13/16-inch and had a shop-applied inside and outside coating of coal-tar pitch enamel; it checked for flaws by an electric detector. An exterior protective coating was provided by a gunite coat on which a wire mesh reinforcement was placed, followed by a second gunite coat.

The pipe was anchored with heavy concrete blocks at 200-ft. intervals and entirely backfilled. This eliminated the need for expansion joints. Bell and spigot welds were made in the field and tested.

In river bottoms, well points were used to keep the trench dry. On steep grades, pipe sections were moved and placed in the excavated trench by side-boom tractors. Rough trench excavation was done with a 2-yd. dragline and fine grading and shaping of bottom trench by hand.



Left, Lock Joint pipe construction; right, welding reinforcement for pipe.

The Navy's resident officer in charge of construction for the work described and for the tunnels was Commander R. D. Thorson. Captain Alden K. Fogg, Civil Engineer Corps, U. S. Navy, who is in charge of construction for the 11th Naval District, was the officer in charge of aqueduct construction and liaison officer with the Bureau of Reclamation.

Tunnel Construction

The San Diego Aqueduct has seven tunnels, varying in length from 500 feet to over one mile. They were designed to carry the ultimate capacity of the aqueduct, 100,000,000 gallons daily or 165 cfs. under free flow conditions. On six of the tunnels, hard blocky granite was encountered which required no supports. Fire Hill tunnel, which is 5350 feet long, was cut through alluvial conglomerate for 3600 feet and beyond that in hard granite. The tunnels are of horse-shoe shaped section, concrete lined and of 6-ft. diameter.

Drilling and heading was accomplished by the means of automatic feed drills. Three of these were mounted on radial arms which were clamped to two vertical columns on a car. In hard rock material, 25 holes were drilled to a depth of 6 ft. and loaded with 115 pounds of 60% gelatin dynamite. Equal results were obtained in soft material by drilling 12 holes 7 ft. deep and loading with 60 pounds of 60% gelatin dynamite.

Tracks were 24-inch gage and 30-pound rail. Ten 2½-yd. side-dump muck cars and 7 1-yd. tipover-type cars made up a train pulled by battery-powered locomotives. Loading was done with air-operated mucking machines.

Tunnel headings were ventilated by electrically-driven blowers which delivered fresh air through 10-inch steel pipe at approximately 2000 cfm. The blowers were reversed after blasting. The ventilating equipment was part of a plant installed at each tunnel portal which also included a diesel-driven generator and a diesel-operated air compressor of 350 to 500 cfm. capacity at 105 psi.

Two types of placing machines were used in tunnel lining work. One was of the conventional type and the other was especially designed for the project. The latter, known as the "Kemper," prevents air pocket formation by means of air forced through the charge of concrete as it drops into the valve chamber.

Arch lining employed three of these 1-yd. placers which were hauled from the batching plant at the tunnel portal by locomotive. The compressed air for operating the placer, including its air control valves as well as needle valve, was supplied by 2-inch line from the portal-located compressor. As each placer was emptied, it was pushed forward on a ramp that straddled the discharge pipe so the next placer could be brought up and discharged.

Placing of the concrete invert was accomplished by other means. Six end-dump cars were dumped from an elevated track ahead of a slip form, which was equipped with stationary vibrators.

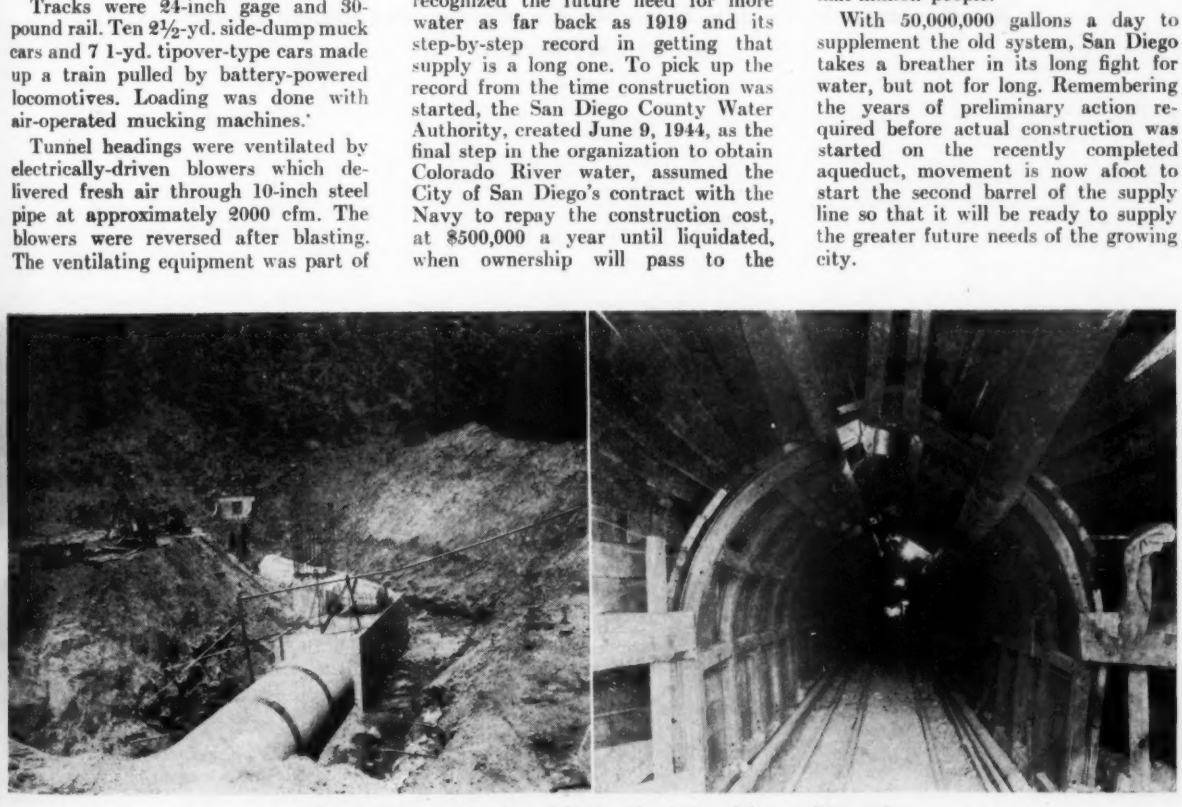
Non-Engineering Problems

While construction was in progress, problems on the governmental side were also being met. San Diego had recognized the future need for more water as far back as 1919 and its step-by-step record in getting that supply is a long one. To pick up the record from the time construction was started, the San Diego County Water Authority, created June 9, 1944, as the final step in the organization to obtain Colorado River water, assumed the City of San Diego's contract with the Navy to repay the construction cost, at $500,000 a year until liquidated, when ownership will pass to the lessee. This action was approved by San Diego voters November 5, 1946.

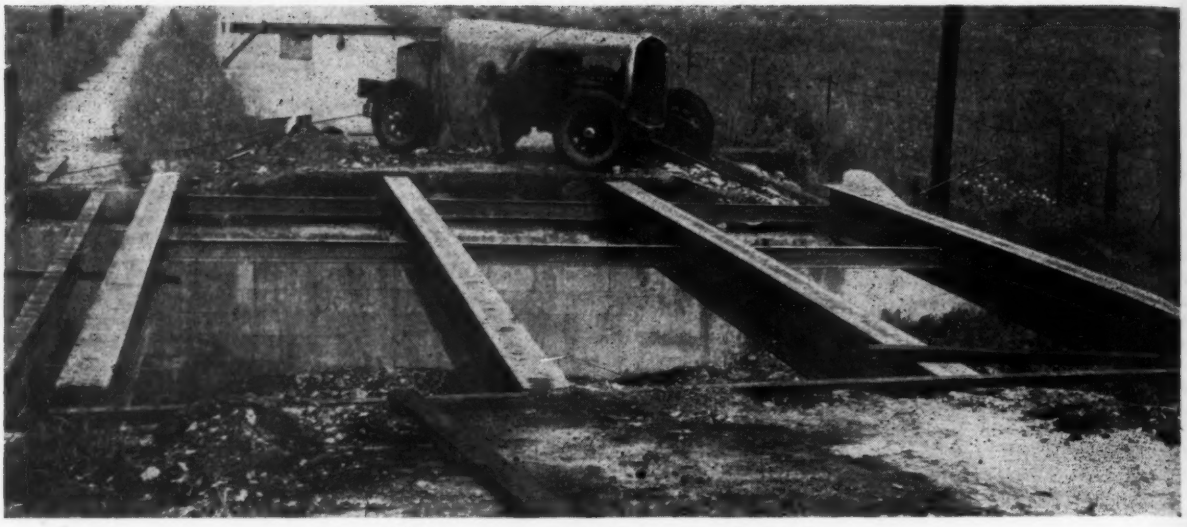
Nine public agencies, including the city and important outlying towns and agricultural areas of the county, are the members of San Diego County Water Authority, which will sell water to San Diego, for example, at $12 an acre foot. To supply its members with Colorado River water, the San Diego County Water Authority, of which J. L. Burkholder is general manager and chief engineer, has let contracts for two extensions of the San Diego Aqueduct. One is a 17-mile line connecting with the aqueduct near San Vicente Tunnel to deliver water to the Sweetwater Reservoir. This serves the National City and Chula Vista areas, south of the city. Edward Green Co., of Los Angeles, has this $1,000,000 contract under way. A more recent contract was let for the other extension from Fallbrook to Oceanside, also 17 miles, but of smaller diameters, to American Pipe & Construction Company, of Los Angeles, for $358,699.

San Diego City had built up its system to a net safe yield of 26.6 mgd. before Colorado River water was brought in. This was more than sufficient to meet the needs of the 1940 population of 202,000, but not enough for the 362,700 population counted in a special census of 1946, when the average consumption reached 49.6 million gallons a day, nor for today's population estimated at close to a half-million people.

With 50,000,000 gallons a day to supplement the old system, San Diego takes a breather in its long fight for water, but not for long. Remembering the years of preliminary action required before actual construction was started on the recently completed aqueduct, movement is now afoot to start the second barrel of the supply line so that it will be ready to supply the greater future needs of the growing city.



Left, gate and venturi section; right, San Vicente tunnel from outlet portal.



The bridge structure partly built, showing method used.

New Bridges for Old by Welding at 40% As Much

HOWARD R. CRAIG
County Engineer, Auglaize County, Ohio

A prize paper in the Jas. F. Lincoln Arc Welding Foundation Design-For-Progress Award.

EVERYONE who drives has stopped or speeded up the car to pass safely another car at a narrow bridge. Many accidents occur at these points. Statistics show the average driver will pull his car away from a bridge rail when it is located at the edge of the pavement. Therefore, the engineer should design the bridge wider than the pavement. For example, on a 200-ft. pavement, the bridge should be at least 24 ft. wide. Drivers will then have less tendency to pull to the center and to crowd the passing car.

All bridge building is done with money from the state or county. From here on we will consider primarily the county setup. The budgets of the average county will not permit any extensive program to correct these conditions. The replacement of one or two large structures is all an average county could hope for in any one year, following standard construction practices. Our county has 857 structures, so the tremendous size of the undertaking is apparent.

Arc Welding a Solution

Through extended study and research we have solved the problem by applying arc welding. In doing this we have been able to salvage 95% of the material from the old structure. Of the 857 bridges, 70% are steel structures, and these are the ones we have under consideration. Every structure presents its own problems, but they are all broadly similar in character.

Simple span bridges are what the name implies. For improvement of these, additional beams can be added and, along with the old beams, tied into a single unit by arc welding, thus allowing a wider, safe bridge and eliminating the bottleneck.

In this article, procedures involving multiple span bridges will be covered. The most accurate way to describe these procedures will be by an example of an actual case:

A 3-span truss bridge failed in the upper chord, requiring immediate repairs. We set timber bents under the two floor beams to maintain traffic while we were securing material for the reconstruction. This truss has three 10-ft. spans, with a total length of 30 ft. The floor beams were built up sections, and not suitable for reuse. The stringers were 7-inch I-beams continuous over the floor beams, six in number. The truss has a roadway of clearance of 15 ft. 9 in. to serve an 18-ft. roadway. The abutments of this bridge had been rebuilt of reinforced concrete in 1935, and were designed for a future 20-ft. concrete beam superstructure.

Steps in Reconstruction

The first step, of course, was the removal of the present structure. All unusable material was hauled to the stock yards. The usable beams and material were cleaned and made ready for use. We then removed part of the wing wall on the opposite side from the walkway. The bridge walk was 6 ft. in width and the approach walks only 3 ft. Therefore, we were able to widen on the walk side without serious detriment to the walk. Incidentally, this walk runs approximately two miles through the country along a county road and is used very little.

For this project, I secured four new 18-inch beams at a cost of $588, this being the only new material purchased for the bridge. Using an 18-inch I-beam and a 4-inch floor, the height above the bridge seat was at grade. Therefore, it was not necessary to alter the abutment seat level. One outside beam was placed on the cut-off part of the wing wall; the other was placed in the middle of the walk, thus giving an overall finished width of 23 ft. 8 in. The other two beams were spaced equally between.

From our stock yard, we obtained 7-inch I-beams for cross beams between the 18-nch stringers. These were placed at both ends and at the third points

between the 18-inch beams. The entire framework was then welded into a solid unit. To the outside 18-inch beams were then welded the rail brackets. The ends of the 18-inch beams were closed off with steel sheets from the stock yard. Expansion was provided for by plates at one end of the structure on the bridge seat.

On this framework we laid a 2-inch by 4-inch strip floor, using treated pine and commercial I-beam clips. Along the edge of this floor was laid an 8-inch by 8-inch wooden wheel guard, and placed a commercial beam-type guard rail which extended beyond the bridge to secure safety.

The use of 18-inch beams eliminated another hazard. The load limit of the old structure was 5 tons and of the rebuilt structure 15 tons. Both safety and strength were thus obtained through welding.

In placing the 7-inch cross beams, small angle iron strips were spot welded to the 18-inch beams, to be used as seats for the cross beams, before these were welded in place. The cross beams were set on these angles and welded to the 18-inch beams, eliminated holding the cross beams in place for welding. The rail brackets and sheets at the end of the 18-inch beams were then welded in place. This welded framework gave us the required structure for the bridge floor and rail. All welds were standard.

The method outlined here for multiple-span bridges can be used on all structures with spans from 20 to 60 ft., which range will cover 75% of our bridges. With bridges over 60-ft. spans, the same welding procedure is used. However, in these cases, a timber pile bent is erected to act as a pier for supporting the main girders. The timber pile bent is also used on shorter spans where headroom or waterway does not permit the use of a deep section beam. When deep section beams are used, bracing is necessary between girders.

In cases where we do not have new concrete abutments, we salvage the old abutment by capping it with reinforced concrete which is inexpensive. In cases where the old abutments are not fit to salvage, we set piling and sheet the back side which makes a strong, but cheap construction. Timber piles are easier to secure than steel.

The completed structure from underneath.

Every bridge job is now a pleasure with the aid and speed of the portable welder, for we need not worry about financing the construction. Figures will show this easier than anything that I might say. The cost figures which follow are not merely welding costs, but are the cost of the completed job, as made possible by welding.

Cost of Bridge (by Welding)

Steel erected (without labor)	$ 604.00
Labor (complete job)	332.64
Flooring	417.17
Guard Rail	36.00
Total	$1,389.81

The cost of a new bridge, for example, of reinforced concrete, can be estimated as follows:

New Bridge Cost

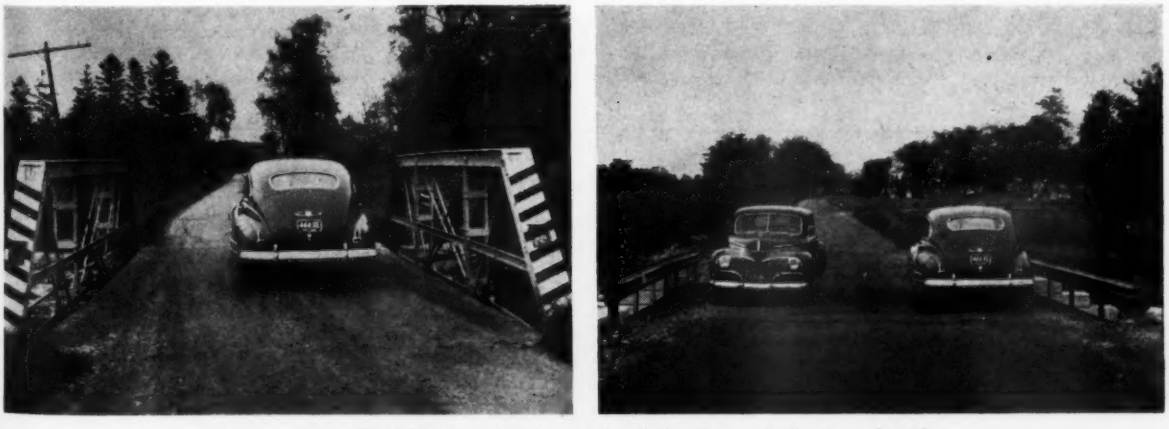
42 cu. yds. concrete	@	$50.00	$2,100.00
12,880 lbs. reinforcing	@	.07	901.60
67 ft. of railing	@	6.00 ft.	402.00
14 sq. ft. joint filler	@	.35 ft.	4.90
126 lbs. bearing plates	@	1.00 lb.	126.00
6 c.i. scuppers	@	4.00 ea.	24.00
Total			$3,558.50

Disregarding the abutment costs, as we have done here, we have a better comparison of the actual saving by welding. Both methods figured here give a loading capacity of 15 tons and equal safety to traffic.

The life of the concrete may be longer than that of the strip floor, but not of the steel structure itself. Therefore, the welding is not lost. When the strip floor does wear out, it can be replaced rapidly and cheaply—in normal times for approximately $250. Strip floors which have been under my jurisdiction have been in use fourteen years and are still in good condition. Counties which have more money may use a reinforced concrete slab over the steel deck in place of strip flooring.

Good engineering practice would not permit construction of a new reinforced concrete superstructure on old abutments, but it will permit this type of construction for the following reason: The old abutment might last one year, or it might last 50 years, we do not know; but if it does fail, little is lost as the welded superstructures can be jacked up, new walls built, and the superstructure reset for use.

By this method we can rebuild 2½ bridges, using welding, for what it would cost us to build one new bridge. We speed up our road program, increase the safety of our highways and save money.

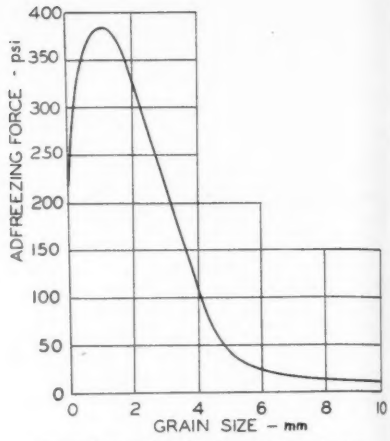


Before and after: The bridge at the left is a bottleneck, but the new bridge is amply wide.

Essentials of Foundation Design in PERMAFROST

JOSEPH D. LEWIN

This is the first of a series of articles on this general subject which will appear from time to time in PUBLIC WORKS Magazine during 1948. Information on construction methods in cold climates is not generally available in engineering textbooks, nor have many data appeared in engineering journals. The general interest in the engineering problems of the far north, and the desirability of making available the information at hand were the factors that influenced our decision to procure and publish these data. This first article is basic in nature. It will be followed by others covering the types of structures generally treated in PUBLIC WORKS, and providing special information needed for their design.—The Editors.



Strength of adfreezing forces by grain size (ice = 200 psi ±).

IN northern areas, as Alaska or northern Canada, the ground is permanently frozen to a considerable depth. Such permanently frozen ground, or *permafrost,* may extend to a depth of over 1,000 ft. Above this permanently frozen layer, is an *active zone* which freezes and thaws seasonally. The upper surface of permafrost is called the *permafrost table,* and this may be from a few inches to as much as 12 ft. below the ground surface. The active zone can freeze either completely down to the permafrost table or only partially, leaving an unfrozen layer or *talik* above the permafrost table. The depth to which the active zone freezes, called the *frost zone,* depends on the thermic regime of the stratum, that is the severity of winter, the thickness of snow cover, the thickness of vegetation and the soil characteristics. If an unfrozen stratum remains, the ground water in it is not frozen and moves between two frozen impervious strata. Often such confined ground water is under artesian pressure. If its pressure is high enough, the ground water can break through the layer of frozen active zone, discharge over the surface and freeze forming a frost mound or *nalyed.*[1]

On the other hand, if the frozen active zone is too thick or if the ground water pressure is not sufficient to break through, it may lift the upper frozen layer into a mound. Underneath, the water may freeze or remain unfrozen. These characteristic occurrences complicate foundation problems in arctic regions. For example, a heated structure is erected on otherwise stable ground. The active zone under such a structure thaws out until the frozen layer is weak enough for the ground water to break through. The water may wash out the foundations or it may freeze upon contact with the air and the resulting ice lift may displace the structure.

Formations and Classifications

Permafrost may consist of geological formations ranging from rock to soft fluid mud and silt. In one respect these are all similar: they have a negative temperature just below freezing. Permafrost has a normal temperature of 31.8°F to 30.2°F; however, in extreme cases the temperature may be as low as 15°F to 20°F. It is obvious that most permafrost layers can thaw rapidly and that small increases in temperatures can cause defrosting to a considerable depth. The stratum just below the permafrost table usually accumulates moisture. This is an important factor, since thawing may cause considerable subsidence of the ground.

Permafrost can be classified as follows: (1) *Dry Ground.*—In a frozen condition dry ground contains either no ice at all, or ice in crystalline form in the voids. Dry ground is not subject to heaving or settling; it does not produce any appreciable volume changes; and in a thawed state its consolidation characteristics hardly differ from those of similar unfrozen soil.

(2) *Moist Ground* contains a limited amount of ice. Loaded, it settles slowly as it thaws and the settlement is only slightly greater than that of a similar unfrozen ground.

(3) *Saturated Ground* is usually fine-grained clayey or silty soil, containing binding ice or ice in the form of crystals, lenses, veins or layers.

[1] A. Tchekotillo: Solving the problem of nalyeds in permafrost region; Engineering News Record, Nov. 28, 1946, pp. 724-727.

SOIL TYPE	PARTICLE SIZE mm	SOIL TEMP. deg. F	MOISTURE % WEIGHT	STRENGTH* psi
Sandy	68% 1.0 to .05 8% < .005	30	21.3	348
Sandy-Silty	63% .05 to .005 11% < .005	30	52.1	166
Clayey	50% .01 to .005 30% < .005	30	53.1	252

* Tests conducted on frozen cubes 2.5" on edge.

TABLE I.— Left: Temporary compressive strength of permafrost at 30° F. TABLE 2.—Right: Allowable bearing values of permafrost of original temperature and ice content.

SOIL TYPE	PARTICLE SIZE mm	ALLOWABLE BEARING VALUES (psi) AT VARIOUS SOIL TEMPERATURES (°F)		
		31.6 - 31.1	31.1 - 29.3	below 29.3
Sands	100% <1.0 <3% < .005	50	64	85
Clayey Sands	<10% < .005	36	50	64
Clayey Silts	10% to 30% < .005	28	43	57
Clay	> 30% < .005	21	36	50
Silts, Muds	> 50% .01 to .005 < 30% < .005 <10% organic	14	28	43

When frozen solid, it has the consistency of soft rock and its bearing values normally increase with lower temperatures. Table 1 gives approximate bearing values which are based on compression tests of standard size cubical specimens. For allowable soil bearing values, use Table 2. Furthermore, in a frozen state, these grounds possess considerable tensile and shear strength.

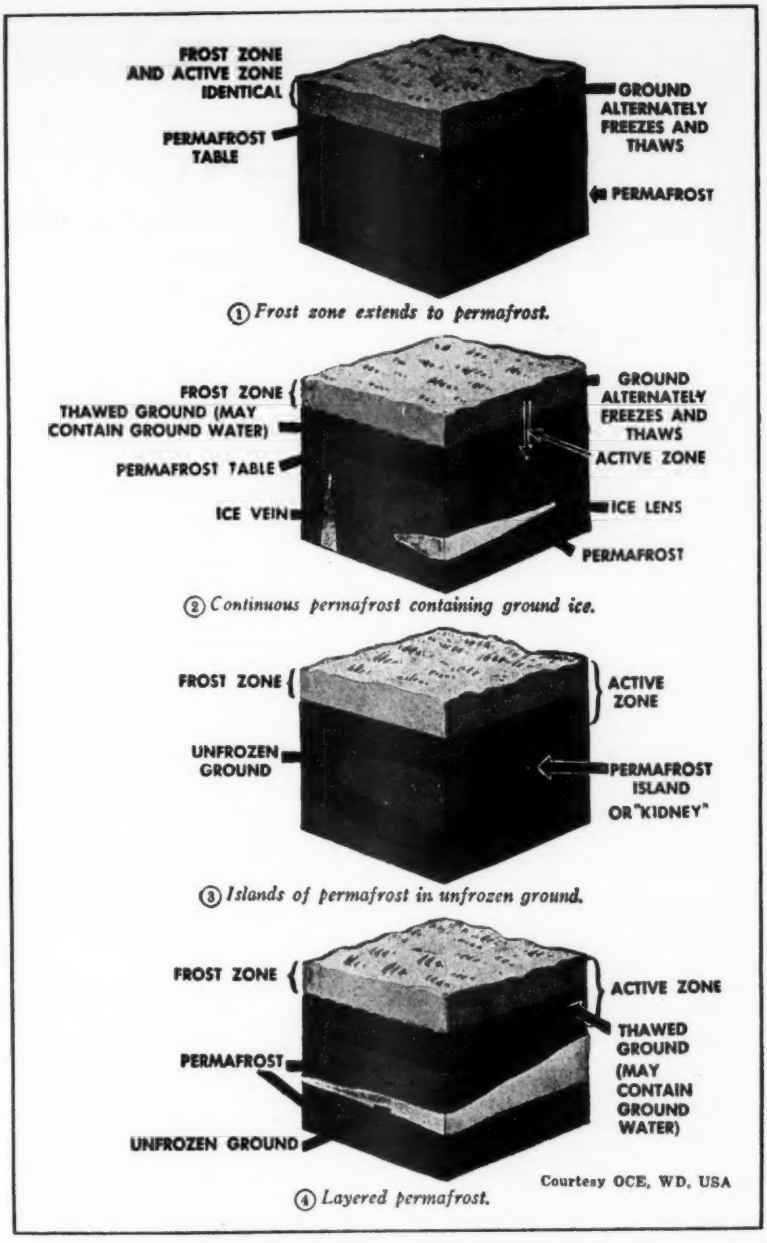
Saturated grounds when thawed, are very soft and yielding and, depending upon their ice content, sometimes reach a miry consistency. If frozen ground contains ice in the form of lenses, veins, sheets or underground nalyeds, the ground settles appreciably on thawing and cave-ins are a common occurrence. Large amounts of ice can cause plastic deformations under loads, and even plastic flow of frozen ground.

Foundation Design Factors

Apart from the mechanical properties of permafrost, adfreezing is of great importance. Adfreezing is the freezing of the ground to piles or foundations; it can occur not only between the structure and the active zone, but also with the soils below the permafrost table which are thawed during construction. Adfreezing is highest in sands, lowest in coarse gravel.

To design a foundation properly, it is necessary to know all the characteristics of the local permafrost. Since the permafrost regime may vary greatly, even in the same general vicinity, investigations should be made at each building site. Vegetation cover, slope of the ground surface, location in regard to the sun and to prevailing winds, all have pronounced effects on the permafrost regime. Subsoil investigations should reveal the thickness of the active zone, its moisture content, its granulometric composition, location of the permafrost table, its temperatures, its minimum thickness. Also the maximum depth of freezing of the active zone and its thawing in summer. The present vegetation, precipitation, snow cover, air temperatures, wind direction, location to the prevailing winds (lee or wind side), in the sun or in the shade, etc., should be recorded. If a long east-west structure is placed on an originally open site, it will cast a shadow in the northern direction. This would shield the active zone from the sun and therefore cause it to freeze more intensely than originally. This can either freeze the active zone to a greater depth or raise the permafrost table.

Permafrost can be grouped into four regions in accordance with its stratification: (1) Region of solid stationary permafrost. (2) Region of stratified permafrost consisting of layers of frozen and thawed ground, or where solid permafrost has an inclusion of thawed layer or layers. (3) Region of permafrost with talik islands or inclusions. (4) Region of thawed ground with permafrost islands or inclusions.

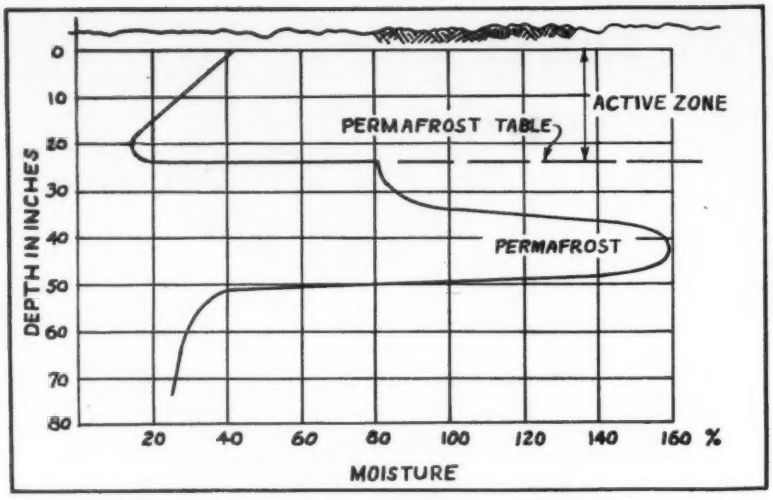


Typical sections through ground containing permafrost.

The location of the permafrost table may be affected by structures above it. It either rises or recedes depending on whether the structure is cold or warm. Such changes in the thermal regime may be followed by deformations which can be caused by swelling, settling or sliding.

The swelling effect is similar to any ordinary swelling. However, since the northern winter is more severe and the freezing is deeper, the swelling forces are more pronounced. The structure, or part of it, may be lifted and gradually pushed out of the ground. This occurs particularly with shallow foundations which are not properly drained permitting an accumulation of ice or even a nalyed under the structure.

During thawing of sandy-silty soils, the structure slowly displaces the soft or plastic ground and sinks into it. Such sinking is mostly non-uniform and can reach considerable proportions. However in more stable grounds, unequal settlements are only slight. The connection between settlement and thawing can be deduced from the fact that heated structures settle more than unheated ones. In each individual structure the footings transmitting more heat settle most. In unheated structures, the settlements on the south side (sun exposed) are more pronounced than on the north (in shade).



Moisture distribution in active zone and the upper permafrost layer.

Russian Experiences

Settlement of a locomotive repair shop in Siberia continued for many years. An investigation disclosed that the clay ground had been defrosted to a considerable depth below the footing of the foundation. Column footings of a steam-electric power house built in 1930 were set in the permafrost layer. The boilers and steam turbines were set on piles. Both piles and footings were placed at about the same depth. Settlement soon started. The boilers and steam turbines settled first. The columns of the reinforced concrete frame structure settled soon thereafter. Until 1934 the settlement of turbines was more pronounced than that of a column; thereafter both settled about evenly. Columns in the boiler room and in the generator room settled least.

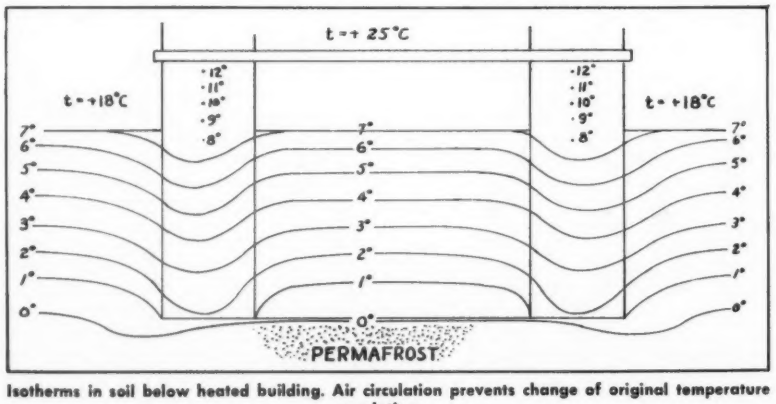
Important theoretical conclusions can be drawn from the settlement which occurred in the above mentioned power house. At first the most rapid settlement occurred under the boilers, where the heat was greatest. This was followed by the steam turbine room and finally by the building columns. In 1934 all parts were settling at an accelerated pace, thereafter the settlement rate decreased and in 1937-1938 the settlement was stabilized. Prof. Eremin, who investigated this project, observed that the permafrost table receded until, in 1934, it reached the level of the foundation. During 1931 to 1934, the permafrost table was lowered by 5 ft. In the following four years an additional 23 ft. were defrosted, causing the rapid settlement. Until 1934 the foundation was hard; in 1934 it thawed and became soft. At it happened, the upper permafrost stratum at this depth had a high water (or ice) content, but the lower soil strata had a smaller ice content, thus accounting for the variations in settlement.

Effect of Ice

An accumulation of ice just below the permafrost table is quite common in the arctic. Since the high ice content will result in a considerable settlement when the ground is defrosted, the necessity for a thorough sub-soil investigation is obvious. Particular care should be taken with the stratum below the permafrost table.

In the process of thawing a thermal equilibrium is reached when the heat from the outside is equal to the cold from the permafrost strata. Once such equilibrium is reached, any further thawing and its concomitant subsidence is stopped. Thermal equilibrium is possible in cases of buildings with a limited output of heat, such as structures for light manufacturing, schools, public offices, housing. However, industrial plants like power plants, boiler rooms, foundries, steel plants, kilns, etc., liberate so much heat that a thermal equilibrium is never achieved and therefore the thawing will continue. Since permafrost often has alternating strata with high ice content, the rate of settlement varies depending upon which layer is subject to thawing.

The second article in this series, completing the section on Foundations, will appear in the March issue.—The Editors.



Isotherms in soil below heated building. Air circulation prevents change of original temperature gradation.

Revenue Bonds for Sewage Plant

Tne city of Ames, Iowa, with an estimated population of 14,500, recently sold revenue bonds totaling $115,000 at an effective interest rate of 2½ per cent for the construction of a sewage disposal plant, outfall sewer, and appurtenances. The annual operating cost of the plant has been estimated at $26,100. Debt service charges and operating costs will be paid from revenues received from sewer service charges based on the cubic feet of water consumed. Iowa State College will contribute 30 per cent of the cost of all construction and maintenance. Every lot or building which uses the sanitary facilities of the city or in any way uses or discharges sanitary sewage, industrial waste, water or other liquids either directly or indirectly into the sewage system will pay a monthly service charge of 10¢ per 100 cubic feet for the first 1,500 cubic feet or less of water used per month, 8¢ per 100 cubic feet for the second 1,500 cubic feet, and 5¢ per 100 cubic feet for all over 3,000 cubic feet of water used. The minimum monthly charge is fixed at 50¢ for each water meter. Charges for sewer service outside the city are 100% higher. A 10% penalty is added to sewer bills not paid within 10 days and bills that are delinquent 30 days and unpaid on July 10 of any year are certified to the county for collection on the same basis as property taxes.—*Public Management.*

Research in Wood Engineering

The 1947 report of the Timber Engineering Co., Washington 6, D. C., illustrates and describes (1) research facilities for wood product development and wood chemistry; (2) the use of Teco connectors for bridges, trusses, frames and other engineering structures made of wood; and (3) typical designs and specifications on materials and structures. A copy will be sent on request.

Water and Sewer Trenching—Paving Breakers

Courtesy LeRoi-Cleveland

The various tools available for pavement breaking, clay spading, pile driving and similar necessary jobs in trenching. How to get the most out of your equipment.

THOUGH this article is designed primarily to describe tools of use in trenching for water and sewer pipes, all-around utility of the various types of paving breakers on many other types of construction makes it desirable to mention some of these uses. They can be employed for breaking pavement surfaces for trenching; for excavating frozen ground, hard-pan or other tight soils; for drilling, if necessary, because of the presence of rock in the trench; for driving sheet piling; for driving posts; for tamping backfill; and for driving spike or drift-bolts on bridge or similar construction.

While any one single breaker may not be most efficient at all of these jobs—which would naturally be expected to require machines of different weights and design—nevertheless, a good all-around machine can be purchased which will satisfactorily perform all of these jobs for the average city or county. If the amount of work justifies more than one unit, then variety in size is desirable.

Kinds of Paving Breakers

The Syntron paving breaker is rather unique because it does not require an air compressor, but takes its power from a self-contained gasoline engine, using about 2 quarts of low test gas per hour. This tool without the paving breaker weighs 97 lbs., and can be transported to the site of the work in a passenger car or light truck, if necessary. There are no batteries, no hose, and no accessories. It can use the various types of chisels, blades, tampers and drivers discussed hereafter.

LeRoi-Cleveland, Jaeger, Worthington, and Ingersoll-Rand furnish many sizes of air compressors. Table I, from Jaeger, shows the number of tools that can be used with various compressor sizes and air pressures. The accompanying illustrations show many of the tools that can be used.

TOOL	NUMBER OF TOOLS													
COMPRESSOR SIZE	60		105		160		210		315		365		500	
LBS. AIR PRESSURE	70	90	70	90	70	90	70	90	70	90	70	90	70	90
Backfill Tamper	3	2	6	4	10	6	14	9	22	16	24	18	31	20
Trench Digger	3	2	5	4	8	6	11	8	19	14	21	16	26	19
Clay Digger	3	2	5	4	8	6	11	8	19	14	21	16	26	19
Paving Breaker 50 Lbs.	1	1	2	1	4	2	5	3	9	5	9	5	13	8
Paving Breaker 80 Lbs.	1	1	2	1	3	2	4	3	7	5	7	5	11	8
Paving Breaker 85 Lbs.	1	1	3	2	4	3	6	4	11	7	11	7	16	11
Sheeting Driver 80 Lbs.	1	1	2	1	3	2	4	3	7	5	7	5	11	8
Sheeting Driver 85 Lbs.	1	1	3	2	4	3	6	4	11	7	11	7	16	11
Rock Drill 45 Lbs.	1	—	2	1	3	2	4	3	6	4	6	4	9	7
Rock Drill 55 Lbs.	—	—	1	1	2	1	3	2	5	3	5	3	8	5
Rock Drill 60 Lbs.	—	—	1	1	2	1	3	2	5	3	5	3	9	5
Wagon Drill	—	—	—	—	—	—	1	—	1	1	1	1	2	2

Courtesy Jaeger Machine Co.

Table I.—Tools that can be operated by air compressors.

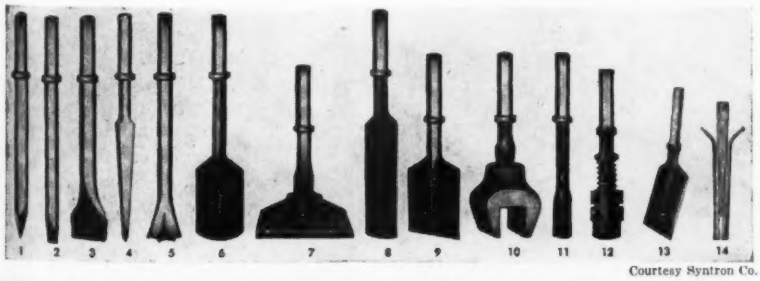
In general, these air-operated paving breakers are built in rather definite size groups. The 30 to 50-lb. sizes are for light work in frost, clay, macadam and general breaking. Units of the next size weigh around 60 pounds and will handle somewhat heavier work, as shale digging, and concrete floor and wall breaking. The 80-85 pound group is the workhorse of the field. It is the lightest unit ordinarily equipped with a pile-driving head, though some of the 60-pound group can be so equipped. These tools are suitable for the light steel piling ordinarily used for water and sewer work, and for 2" or 2½" wooden sheet piling, but not for the heavy steel sheeting.

Larger than these are a variety of breakers and drills, some of which have slower, heavier or longer strokes, suitable generally for stiffer and harder ground in pile-driving, and for rock drilling and heavier breaking operations not normally needed in trenching work.

Getting the Most Out of Your Paving Breakers

These data are based on helpful advice from LeRoi-Cleveland. After urging proper oiling and maintenance to keep the machine tight, and recommending the right size of machine for the job, advice is given on the kind of tools and how to use them. Contrary to general practice, the use of the narrow chisel is recommended in preference to the moil point for pavement breaking. The moil point exerts wedging pressure in two directions, as shown in the illustration, and that exerted parallel to the edge of the hole being made is largely wasted. With the narrow chisel, all of the energy is applied toward breaking up the material. Wide chisels are not suitable for breaking concrete; to use them means more chisel breakage and less work done. The wide chisel is recom-

(Continued on page 34)



Courtesy Syntron Co.

1. Moil Point; 2. Gad; 3. 3" Chisel; 4. Frost Wedge; 5. Drill Steel; 6. Clay Spade; 7. Tamper; 8. 3" Digger; 9. Asphalt Cutter; 10. Sheathing Driver; 11. Ground Rod Driver; 12. Spike Driver; 13. Offset Trimming Spade; 14. 2" Plug and Feathers.

Small Sewage Treatment Plants

I—Volume of Flow

Sewerage facilities are needed by 9,058 communities in the United States having less than 5,000 population each, according to the U. S. Public Health Service survey of needed facilities. Available data do not show how many of these communities need sewage treatment facilities, but they do show the probable cost of the plants needed.

In the population group 1,000—5,000, the estimated cost of sewage treatment projects reported ready for construction amounts to $31,276,000; for those where planning is in progress, the estimated cost is $105,933,000; the additional ultimate need is for $421,473,000.

In the population group 500—1,000, the projects ready for construction are estimated to cost $10,291,000; those with planning in progress, $34,685,000; and those needed eventually an additional $173,487,000.

In the very small population group, 200—500, sewage treatment projects reported ready for construction total $1,227,000; those in progress of planning, $15,128,000; and those eventually need an additional $247,617,000.

Here is a total of work amounting to $42,594,000 reported ready for construction, and plans in progress for $155,746,000—a total of nearly $200,000,000, plus a much greater sum needed in the future.

Here are several thousand small communities which need—and will get somehow—these desired sewage treatment facilities. It is the purpose of this series of articles to help them get the most modern and usefully long-lived plants that it is possible to get.

To the small communities needing sewage treatment we present this advice: Read these articles; see what you can get for your money in modern, efficient and pleasing plants; and then employ the best consulting engineer you can find. He will save you money and give you a structure of lasting benefit.

FOR the purpose of this series of articles, small sewage treatment plants will be considered as those serving not less than 500 nor more than 2,000 persons; but the principles of design and the equipment presented are suitable for both larger and smaller installations. This first article of the series is devoted to data on volume of flow; the next article will consider primary settling; others will discuss the various types of secondary treatment, sludge digestion and similar important subjects.

Fenton, Mich., plant has Jeffrey equipment.

Plans for these small installations must, of course, be submitted to the state sanitary engineer for approval, and the plans must be accompanied by an engineering report. Because small plants frequently present difficult problems in design, unusually thorough investigations and reports are often necessary. These problems may arise from such factors as wide variations in flow with very low night flows; the presence, in some places, of industrial plants contributing wastes; the necessity for, or possibility of avoiding, pumpage of raw sewage; the need for not more than one-man, one-shift, or even of part-time, operation; and similar factors.

Gathering the Data

In gathering the data on which to base design, no factor should be overlooked. Among the points usually to be observed are:

(1) A study of the water consumption and water use, including pumpage or other measurement of the community supply, with variations by days and months; consideration of industrial or private supplies that may contribute to the sewers. If the water supply is still to be built, the State Sanitary Engineer can be helpful in advising and furnishing data from other similar communities regarding water use and sewage flow.

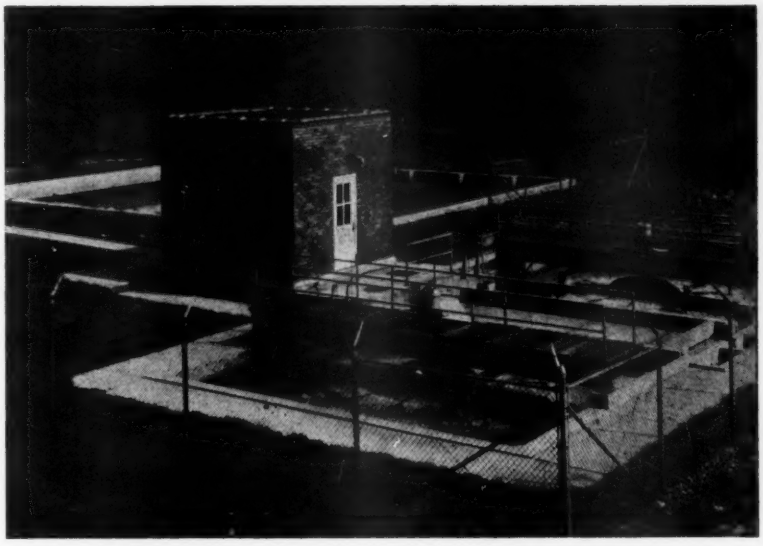
(2) Probable industrial waste discharges should be determined with great care. Every laundry, creamery, milk plant, abattoir, canning plant or other industry producing liquid waste or using water in processing should be canvassed to determine the character of the wastes discharged, their organic content and volume, and the schedule of discharge.

(3) Ground water infiltration should be considered. If a sewer system already exists, the flow in both dry and wet periods should be measured. If the project includes sewer construction, the areas through which the sewer passes should be considered to decide whether they are water bearing. The actual amount of infiltration depends largely upon the skill and care with which the lines are built. In wet soil, a considerable allowance should be made for infiltration.

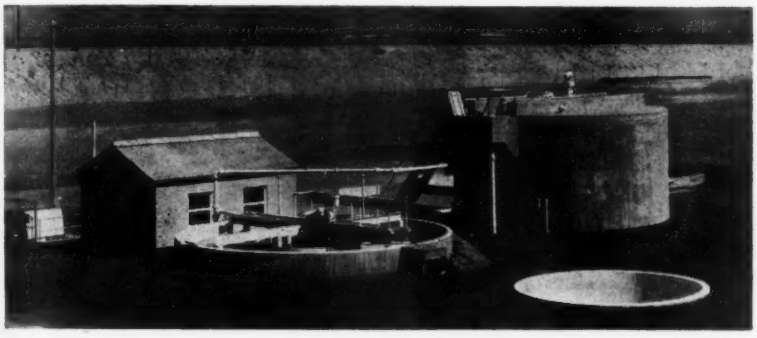
(4) Consideration of the characteristics of the water supply is desirable. This factor does not often affect sewage treatment plant design, but it may on occasions. Excessive hardness, alkalinity, acidity or special mineral content should be noted.

The domestic sewage flow may first be considered as to volume and hourly rates of flow; the industrial wastes may then be added according to their time schedule of discharge. If there are seasonal loads, as in summer or winter resorts, or heavy week-end loads, these will probably govern capacity, and the off-peak loads may provide a problem in design for minimum flow. Winter heavy loads are generally more important than summer heavy loads. Storm water flows must be considered, often not so much from the viewpoint of treatment, as of handling through the plant; also whether excessive amounts of grit or sediment will be carried by such flood flows.

These flow data may be plotted graphically to show the volume and the total organic load to be handled during average and maximum 24-hour periods. This will give a picture which may be helpful in working up the plans for the plant; but before starting that job, the data for the present must be projected into the future. It will be necessary to design the plant for 10 to 20 years hence. The probable growth of the community, the direction this growth will take, the growth of its industries, the coming of new industries, and other similar factors must be estimated. There is no sure way of being right in this job of prophesying. The opinion of local real estate men, of the telephone and lighting companies, and of local citizens will help. However, good sense will go a long way in forecasting. A local laundry may grow, depending on nearness or easy accessibility to a considerable population, an ample supply of water, local cheap labor, etc. A canning plant of any size is unlikely where fruit or vegetables are not grown; nor a creamery or milk plant where there is no considerable local milk production.



A Chicago activated sludge "Package" plant at an institution in Indiana.



Dorr equipped plant at Navy depot, Anaheim Bay, Calif.

Sewage Flows for Small Plants

The collected data plus the evaluation of future probabilities will determine the general size of the plant. However, nearly every state has minimum standards of sewage flow for design, based on long experience throughout the state. It is not often that flows determined as carefully as has been outlined here will have to be revised materially upward; but they should always be checked against state requirements.

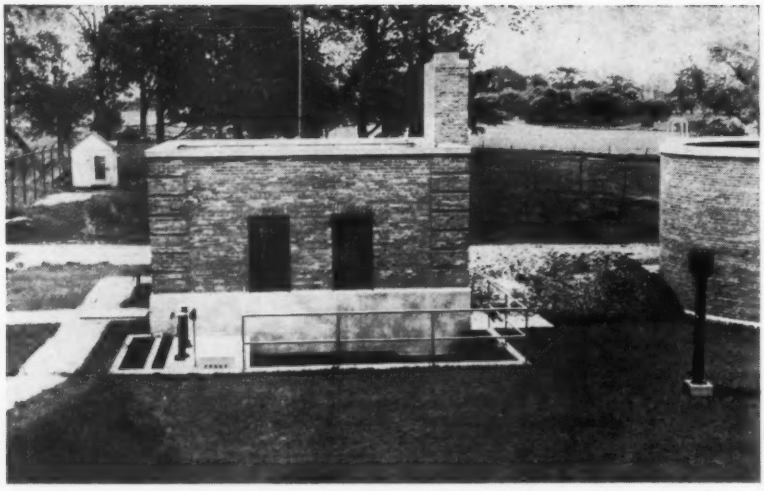
Of 36 states writing us in regard to design flows, the following provided more or less specific information on assumed or required flows for small plants:

State	*Gpcd.*
Arkansas	60–80
California	60 min.
Connecticut	100
Delaware	100
Florida	100
Georgia	35–100
Kentucky	60
Maine	50
Montana	100
New Mexico	70
New York	100
North Dakota	60
Ohio	100
Oklahoma	50
Oregon	50–100
South Dakota	40–60
Texas	50–70
Tennessee	100
Virginia	50–70

Arkansas, *F. L. McDonald*, Chief Sanitary Engineer, uses 30 gpcd. for schools, camps, etc., which is reduced to 15 for schools without showers. For small communities, the usual flow is 60 to 80 gals. Connecticut, *W. J. Scott*, director of the Bureau of Sanitary Engineering, suggests 25 to 40 gpcd. for factories, 100 for municipalities, 125 to 200 for institutions, 15 for schools without showers (30 with), and 60 for camps and boarding houses. Indiana, *B. A. Poole*, director, Bureau of Environmental Sanitation, uses 20 gpcd. for schools without showers, 30 with showers, and 100 gpcd. for normal conditions for camps and hotels; but requires a careful study of the local situation in small communities, including water consumption, flow in sewers (if there are any), and estimates of local industrial wastes. New Mexico, *Charles G. Caldwell*, director, Division of Sanitary Engineering and Sanitation, recommends 20 gpcd. for schools, 50 for dwellings and 70 for a normal small community where there is no considerable contribution of industrial waste.

New York, *S. T. Barker*, chief, Bureau of Sewage and Waste Disposal, Division of Sanitation, uses 100 gpcd. for small communities; 25 to 75 for camps; 75 to 125 for institutions, except hospitals; 150 to 250 for hospitals; 20 for day schools with showers; and 15 to 30 per person per shift in factories. North Dakota, *J. H. Svore*, director of Sanitary Engineering recommends 60 gpcd. for small communities. Montana, *H. B. Foote*, director of Sanitary Engineering, 50 to 65 gpcd. for camps, 50 for hotels, and up to 100 for small communities, depending on local conditions. Iowa, *A. H. Wieters*, director of Public Health Engineering, considers the average rate of flow to be 30 to 40 gpcd. over a 16-hour period, with allowances for infiltration of 10,000 to 15,000 gals. per day per mile of sewer. Virginia, *Richard Messer*, director of Sanitary Engineering, 50 to 70 gpcd. plus allowance for infiltration for small communities. Texas. *V. M. Ehlers*, director of Sanitary Engineering, estimates average flow from small communities, camps and hotels at 50 to 70 gpcd.

Oklahoma, *H. J. Darcey*, chief engineer and director, Bureau of Sanitary Engineering, writes: "The volume of



The Chain Belt equipped plant at Hales Corner.

sewage flow for small communities is usually 50 gpcd. for the entire population of the community. For the past year and a half, we have been making studies of sewage disposal problems and have otained actual gaugings of sewage flow as follows:

Community	*Population*	*Sewage Flow*
Elk City	7500	50
Henryetta	9000	34
Hugo	6500	55
Perry	6000	49
Poteau	5800	34
Temple	2000	46
Watonga	3000	77
Walters	4000	42
Woodward	6000	63

Kansas, *James B. Arbuthnot*, Sanitary Engineer, says: "We insist that the flow be measured wherever sewer systems exist; where it cannot be measured, we insist that the factor of safety be large enough to take care of the factor of ignorance."

Comments by Others

W. W. Towne of South Dakota writes: "I note you classify small plants as ranging from 500 to 2000. When we get up to 2000, we are getting into a large plant for us. For the small municipal plants up to 1000 or 1500 population, we still favor Imhoff tanks, primarily because these small municipalities do not have the personnel nor the facilities to maintain more complex plants. Due to lack of dilution for sewage plant effluent, we are conservative on our trickling filter loadings, as many of the small plants discharge into entirely dry water courses."

"Treatment plants for towns of 500 to 2000," says *R. P. Farrell* of Tennessee, "should be considered each as a special case and should be designed by a competent engineer. Because of the wide variation in conditions, we do not have arbitrary standards." *Charles G. Caldwell* of New Mexico says: "We are finding that the so-called 'package' plants have a place in small towns and are often more economical to install. One town of about 1800 is now contemplating such an installation. Even better treatment facilities can be afforded in even smaller communities."

Paving Breakers for Trenching

(Continued from page 31)

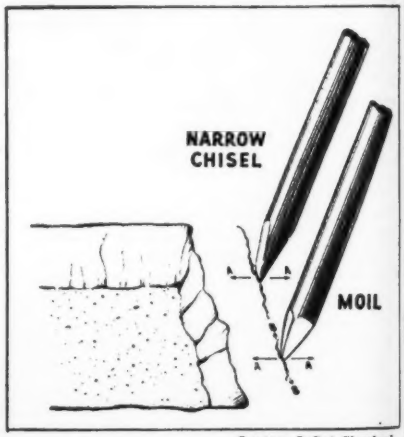
mended for asphalt, brick, etc., but for surface asphalt, the standard asphalt cutter is recommended.

Furthermore, LeRoi-Cleveland says, the digging blade, spade, clay blade or wide chisel is for heavy clay, broken shale, ice formations and the generally lighter classes of paving breaking. Badly worn chucks and dull points are causes of chisel breakage. Also, a dull cutting edge or a dubbed moil point causes the energy of the hammer blow to be absorbed in the tool itself instead of in breaking the concrete or earth. Tool shanks should be tempered so that a sharp testing file will just take hold. Shanks too hard or too soft will give trouble.

Ingersoll-Rand utility drilling unit.

Largely because conditions vary considerably, estimates of savings by the use of paving breakers, clay spaders, pile drivers, tampers, etc., are not readily available. In general, a machine of this type will save $30 or $40 per day over hand labor doing the same kind of work. According to Army experience, one paving breaker operator will break up to 15 sq. ft. of 6-inch concrete or asphalt pavement in an hour; a clay spader, working in hard tight clay, will loosen about 1¼ cu. yds. of clay per hour; a rock drill operator will sink abut 8 ft. of 1-inch hole per hour. Skilled workmen may do considerably more under favorable conditions. Very large savings are possible in tamping around street openings, for backfill in trenches, and close to curbs, structures or culverts. In such cases, dirt is usually tamped in 2-inch or 3-inch layers.

Syntron self-contained gasoline hammer.



Courtesy LeRoi-Cleveland

Advantages of narrow chisel in pavement breaking. **See text on page 31.**

Raising Sunken Gutters by Guniting

Sunken gutters were raised as much as 6 inches by guniting at a cost about one-third that of new curb and gutter construction.

J. C. SEELYE
Acting City Engineer

FOR the past several years the city of Pueblo, Colorado, had been trying to find the most economical method of raising sunken gutters. Last year we experimented with "Guniting," especially on the gutter sections where the concrete was broken and could not be raised by the mud-jack method. These sections were built up to grade.

The curb and gutter that this method was used on had been in place for 20 to 30 years and was laid with a ¼-inch expansion joint every six feet. Due to the fact that the base was not stabilized and to the frequency of the expansion joints, water accumulated under the gutter, causing it to sink—as much as six inches in places. Although some of the settlements were caused by broken water services, or improperly compacted water or gas service trenches, these were in the minority, and caused only one or two of the defective sections. We were fortunate that our standards call for a 9-inch curb head so the gutter sections that we built up as much as 6 inches still showed a curb head of 3 inches. We attempted at first to raise the curb heads also up to grade by guniting a cap on them, but due to the small area for bonding this method was not successful, and we stopped that type of work. We felt that by getting rid of the water holes, which at times became stagnant and caused many complaints from property owners, we would be eliminating the main trouble, and the property owners would ignore the looks as far as the height of the curb head was concerned.

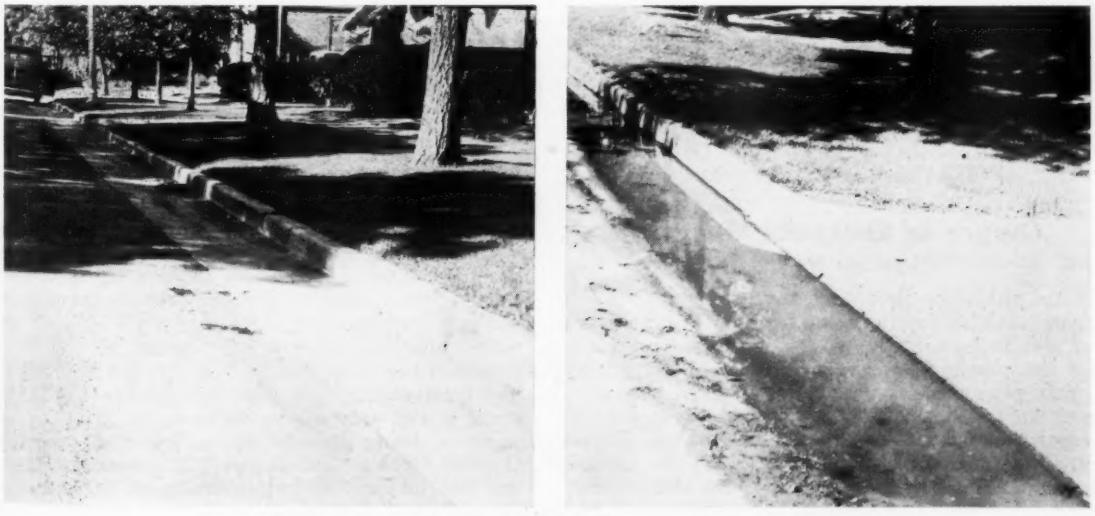
Procedure in Guniting

We gunited sections from 20 to 300 feet long. On short sections we stretched heavy string and brought our grade up to that; on sections 40 feet and longer we used an instrument and drove nails in the expansion joints at 18-ft. intervals to mark the flow line we wanted. The edge of the gutter was similarly marked by driving nails between the gutter and the pavement. In most cases the paving was down almost as much as the gutter. If it was concrete pavement it was brought up with the gunite machine; if asphalt, a repair crew followed in a few days and raised the asphalt to grade.

We found that the most important part of the work was in getting the surface to be gunited absolutely clean; that is, to remove all oil, scum and other accumulations of that nature. This was done, of course, by sand blasting with the gunite machine. We found that particular attention must be given to the edges of the work where the patch will be feather-edged. The work we did last year withstood a very severe winter, with considerable ice accumulation in the gutters. The only spalling we had occurred where the surface of the old concrete was not cleaned properly. We did not have any trouble at all where proper precautions had been taken with the cleaning.

The cost of this operation ran from 40 to 60 cents per linear foot, with approximately 20 cents of that cost being absorbed in the cleaning. This cost would have been reduced materially if we had owned our own machine, but we had to rent the equipment which cost $6.00 per hour with operator, in addition to which the City furnished two men and a truck, and all materials. Due to the fact that some areas were harder to clean than others the cost of sand blasting varied greatly and it was rather difficult to keep an accurate cost on the jobs, so we averaged them and arrived at the figures quoted above. The present cost of combined curb and gutter is approximately $1.65 per linear foot, so we effected quite a saving; and as almost a year has passed since we did the work, and it shows no appreciable deterioration, I would say that the method is a success. At least that is our judgment so far.

This work was done under the direction of Herman Klipfel, Commissioner of Parks and Highways, and supervised by Henry MacFarlane, Street Foreman.



Curb before repair at the right, showing standing water; after repair, at left.

Legal Decisions Re:

Sewerage and Refuse

Refuse Collector's Contract Construed by Court

A garbage and refuse collector was denied damages for failure of a town to conform to an ordinance which it had passed and to a seventeen-year contract with the plaintiff to collect rubbish and garbage from the municipal district and haul it to a dumping ground outside the town limits. The evidence showed that for four years, the plaintiff had failed to collect regularly garbage and rubbish from restaurants, business places and other points of collection, so that the accumulated waste became a nuisance, making it necessary for citizens either to haul away the waste or arrange for its hauling by third persons; and for three years, because of wartime restrictions and conditions, garbage containers could not be obtained and the collector had not been able to provide a vehicle constructed as prescribed in the ordinance for the hauling of the garbage, but had to resort to the use of open trucks. The collector could not have specific performance of the contract when he could not show that he had complied with its terms by performing or offering to perform, on his part, the acts which formed the consideration of the undertaking on the part of the defendant town; and he could not recover damages on account of his default in handling the garbage of the town. Gibbons v. Town of Hot Springs, New Mexico Supreme Court, 178 P. 2d 400.

Creating a Special Sewer System District

A sanitation district was denied injunction against the City of Denver from creating a special improvement district for the construction of a sanitary sewer system where the plaintiff district had made no progress, for a year after the lands had been lawfully assessed to the city, in accomplishing its plan to establish sanitary sewer service to the residents in that portion of plaintiff's original territory which had become assessed to Denver, the city having, under its charter, authority to create an improvement district. Garden Home Sanitation Dist. v. City and County of Denver, Coloradio Supreme Court, 177 P. 2d 546.

Owner of Cesspool Must Pay Sewer Rental

An ordinance providing that the municipality may establish just and equitable rates or charges of rent to be paid by owners of realty for the use of the municipality's sewage disposal system by every person whose premises are served by a connection to such sewerage was held to be a valid regulation by the Ohio Court of Appeals. Colley v. Englewood, 71 N. E. 2d 524. Since the municipality had the right under the State Constitution to acquire the sewer system, the court said, it had also the right to provide for the payment for it by assessment against those enjoying its benefits, if the assessment is equitable, fair and reasonable. In this case an owner whose system of sewage disposal by cesspool, constructed before the establishment of the municipality's sewerage system, was denied an injunction against the collection of a rent charge where he received a benefit from the system which admittedly appreciated the value of his property.

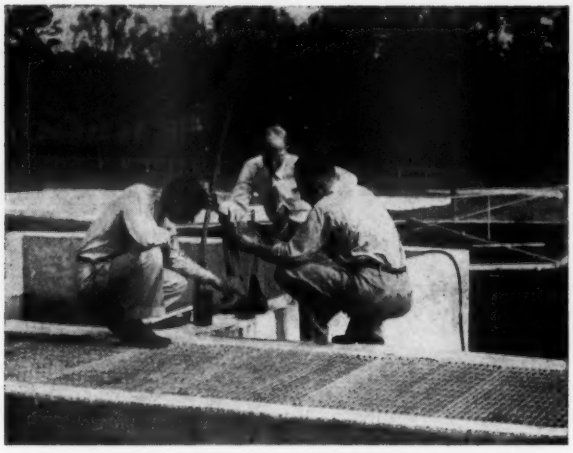
Liability for Neglecting to Make Sewer System Adequate

A municipality may be guilty of maintaining and operating its sewer system in such manner as to constitute a nuisance. In such a case, parties sustaining injury therefrom may maintain an action to recover damages thereby sustained, irrespective of the question of negligence on the part of the municipality. Although a municipality is not an insurer of its sewer system, and will not be held liable in damages because of error in judgment as to the size of drains or sewers necessary to carry away sewage or surface waters, it is generally held that if, after such sewers and drains are constructed, it becomes evident that they are inadequate, as constructed, to perform the functions contemplated, and after due notice it fails to take steps necessary to remedy such condition and continues thereafter to operate the system in such manner as to constitute a nuisance, it will be held liable. City of Ada v. Canoy, Oklahoma Supreme Court, 177 P. 2d 89, was an action for damages alleged to have been sustained by the plaintff because of sewage from the defendant city's main sewer line backing into their homes. The evidence showed that the flooding of plaintiff's premises from sewage from the main sewer line was caused by surface waters breaking into the line, negativing the defendant's contention that its main sewer line only overflowed after an unusual and extraordinary rainfall.

Damage by Seepage from Drain Due to Flood

The owner of dwelling houses sued the city for damages allegedly caused by water seepage from a channel used by the city for drainage and sewage collection. The Ohio Court of Appeals held that the evidence justified a denial of recovery on the ground that the seepage was caused by a superior force consisting of an extraordinary flood and that it could not be prevented by the city. If the negligence of the defendant concurs with another cause of the injury in point of time and place, and the other cause is a superior force which would have produced the same damage whether the defendant had been negligent or not, the defendant's negligence is not deemed the cause of the injury. The evidence being in conflict, the question whether the damage was solely caused by a superior force was for the jury to decide. Judgment for the city was affirmed. Greenburg v. City of Steubenville, Ohio Court of Appeals, 72 N.E. 2d 125.

Learning by doing—applying DDT as a spray.



Students taking samples at a sewage plant.

Public Health Engineering

Field Training Programs

THE U. S. Public Health Service has developed field training programs in sanitary engineering, sanitation, insect and rodent control, and in administration, laboratory, education and nursing. These programs are intended to meet the current needs for specific professional (and sub-professional) groups, as well as to supplement academic training and to develop a pattern for field training procedures. No tuition is charged, but trainees are expected to pay their own living and traveling expenses, either personally or by arrangement with their employers.

Sanitary Engineering Field Training

This program covers a 12-week period and is designed for sanitary engineers in supervisory positions in large local health departments; but it is also available to State Health Department personnel. The instruction program provides for participation in operating a municipal water filter plant, in drilling wells, and in constructing home septic tank installations; inspections and reports on several types of garbage disposal; operating reports on a sewage treatment plant; work on insect and rodent control programs; food and milk sanitation; plumbing; and the laboratory procedures necessary for the above. Laboratory, construction and operational equipment are available. Trainees are divided into teams of 2 or 3 men and these teams rotate during 8 weeks of field practice. Film strips and motion pictures are used extensively in training. This program is available to engineering graduates who have a satisfactory background in environmental sanitation.

A 3-week course in the bacteriological, chemical and biological phases of water supply, sewerage, industrial wastes, stream sanitation and milk and food is also available to graduate sanitary engineers.

Insect and Rodent Control

A 4-week training program in rat-borne disease prevention and control includes: Rat-borne diseases and their importance and epidemiology; how to make surveys; habits and characteristics of domestic species of rats; techniques of rat-proofing; control of rat ectoparasites; and organization of rat-borne disease prevention and control programs.

An in-service program in insect and rodent control is available to certain U. S. Public Health Service and State and local health department personnel. This covers mosquito identification, surveys and control; and rat-proofing, trapping, poisoning, etc.; the use of DDT for dusting; and identification and control of flies, lice, bedbugs, ticks and roaches.

A 4-week program covering malaria and typhus control and basic environmental sanitation has been designed for public health personnel from foreign countries.

No educational qualifications are listed for these courses; health department or other personnel engaged in appropriate activities appear to be eligible.

Training in Sanitation

There are three programs in environmental sanitation. The first is a 12-week course designed for sanitarians with "either an academic background in environmental sanitation or several years of related public health work." It covers urban and rural water supplies and sewage disposal; garbage collection and disposal; school and recreational area sanitation; housing and plumbing; food and milk sanitation; insect and rodent control; laboratory procedures; and allied work.

The second program is also a 12-week course. The first 4 weeks include public health administration, records, bacteriology, nursing and education, and is generally designed to give a basic background. The remaining 8 weeks cover field experience in rural and urban sanitation, rodent and insect control, plumbing, housing and milk and food sanitation. Emphasis is placed on mid-west conditions and the training is carried on in Kansas.

The third program is also 12 weeks long and is much the same in nature as the second one, except that it is carried on in up-state New York and emphasizes the problems of the northeast.

For information on these and other programs that are available, write E. S. Tisdale, Chief, Training Division, Communicable Disease Center, U. S. Public Health Service, Atlanta, Ga.

Incomes of Professional Engineers

A booklet summarizing a study of the American Association of Engineers, 8 So. Michigan Ave., Chicago 3, Illinois, on the incomes of engineers is available for distribution. We have found this interesting, and valuable as a possible guide in establishing suitable grade classifications for engineers. It should be helpful in formulating plans to secure equitable salaries for various personnel groups. It will be sent on request.

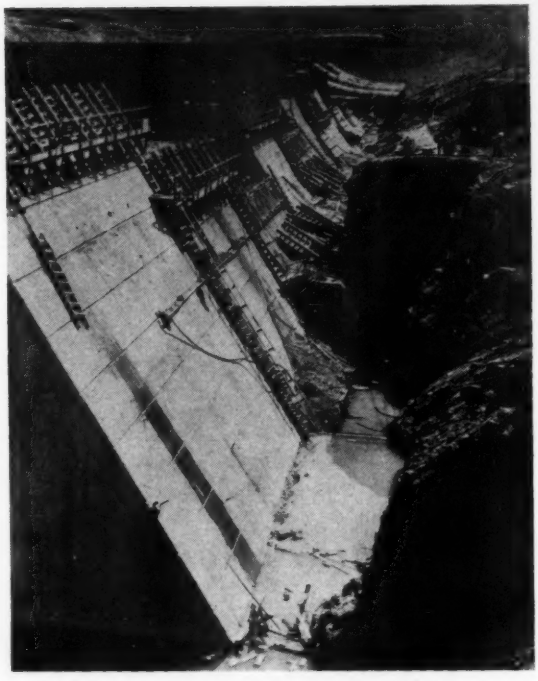
PUBLIC WORKS

Engineering Data

New-Type Forms to Expedite Ozark Dam Construction

The Ozark Dam on the White River in Arkansas will have a total maximum height of 280 ft., and will be 2,256 ft. long. It will require about 2.5 million cubic yards of concrete and will cost approximately $47 million. The steel forms to be used in building the dam will be of the cantilever type developed and furnished by Blaw-Knox Co. This design of form, first used on the Wolf Creek dam in Kentucky and later on the Kansas Fall River and New York East Sidney dams, is illustrated in the accompanying photograph showing the Wolf Creek Dam under construction.

In construction, these forms are anchored to the blocks of concrete previously poured, thus permitting a very large reduction in the number of anchors required. The forms are made in standard panels 10 ft. long, with odd lengths as required, and provide concrete lifts 5 ft. high. Adjustable curved forms provide for the downstream ogee.



Blaw-Knox Cantilever forms at Wolf Creek dam.

Refuse Collection and Disposal Costs

In Easton, Pa., 6,510 tons of garbage and rubbish were collected with city trucks and incinerated. In addition, 960 tons were delivered to the plant by private trucks. This total of 7,465 tons in 1946 represented about 446 pounds per capita, based on the 1940 population. In addition, 8,015 loads of ashes were collected in 1946.

Labor costs for collecting garbage and rubbish were $2.85 per ton; truck costs were 50¢ per ton; other costs were: incinerator $1.17; extra fuel, 17¢; supervision 19½¢; and other costs 17¢.

Unit Costs of Pumping Water

In pumping more than 206 million cu. ft. of water from its deep wells, the Pasadena, Calif., Water Department reports a total expense of 5.81¢ per 1000 cu. ft. pumped against a head of 100 ft. The head at the various pumping plants varied from 53 ft. to 551 ft., and averaged 298 ft. If the costs of "non-operating" plants are included, the total is 6.47¢ per 1000 cu. ft. per 100 ft. head. Power costs represented approximately 3.3¢ of the 5.81¢ total cost.

At the booster plants, more than 448 million cu. ft. were pumped against an average head of 133 ft. Total expense per 1000 cu. ft. pumped against 100 ft. head was 5.70¢. Power costs represented approximately 3.6¢ of the total 5.70¢.

An approximate comparison on the basis of 1 million gallons raised 1 foot can be made by multiplying the above costs by 1.34. This would indicate a cost of about 7.75¢ per million gallons raised one foot for the deep well pumps and 7.6¢ for the booster pumps.

Handling Heavy Water Department Articles

A 1-ton hydraulic crane has been found most useful by the Marion plant of the American Water Works & Electric System. The crane is mounted on a flat-bed truck, and has a telescopic leg support mounted on the underside of the truck body for use when heavy material is handled. The installation was described by Manager L. O. Porter, in *Water*, as follows:

"Our problem was to find some sort of lift with at least a 180° swing which would permit us to load or unload the truck and to lower heavy articles in the trench without resorting to a cumbersome derrick or winch, which would allow us to use the truck for little else. We also wanted equipment with a mast height low enough to permit getting the truck into the garage without dissembling the crane.

"To permit lowering articles in a trench, a reasonably longer boom was necessary. The new crane meets about 95% of our requirements. With the extension boom attached, its capacity is limited to a thousand pounds, which takes care of fire hydrants and 6" and 8" pipe very nicely. If heavier

weights must be lifted, the extension boom must be removed to permit lifting up to one ton."

On one job the crane was used to lower 18-foot lengths of 8" ci. pipe into a trench where it was necessary to slide the pipe underneath gas mains. Three men were able to do the job quickly and with complete safety. One man has also been able to transport fire hydrants to the job.

The crane easily handles equipment being loaded on the truck or unloaded to ground level, but if material is being lowered from the truck to a 4-foot trench, it is necessary to lower it first to ground level on timbers laid across the trench, and then make a new hitch with the crane in its raised position, after which the timbers are removed and the article lowered to position.

On the first job on which the crane was used, four men installed about five hundred feet of 6" pipe and one fire hydrant, made all connections to existing mains, and backfilled the trench with an angle-dozer in two days.

When installing pipe, procedure is to first lower the pipe into the trench; then insert the spigot end in the bell, using the crane; use a bar to jam the pipe home; and, after blocking, allow the pipe to settle properly.

Highway and Sanitation Equipment Repair Procedures

In a study by the author for the city of Philadelphia, equipment maintenance and repair procedures were observed in eleven cities.

ROBERT K. SAWYER, Director
Bureau of Municipal Research of Philadelphia

TO OBTAIN information regarding equipment repair procedures, 10 large cities were visited early in 1947. The organization and methods of handling repairs for sanitation and highway construction and maintenance equipment were studied in New York, Chicago, Detroit, Cleveland, St. Louis, Pittsburgh, Washington, Milwaukee, Minneapolis and Newark. In New York, the study of repair organization was limited to the Borough of Manhattan, which is referred to separately in the report.

Organizations Responsible for Repair

In every city studied, sanitation and highway equipment is repaired either by a subordinate unit (bureau or division) of the using agency or by a unit coordinate with the using agency in the same major department.

In New York, equipment is repaired by a bureau of the using agency, a major department whose function is solely street cleaning and the collection and disposal of refuse. In Chicago, St. Louis, Pittsburgh, Washington, and Newark, equipment-repair work is a function of a subordinate division of the using agency, which is a bureau in a major department.

In Philadelphia, Detroit, Cleveland, St. Louis, Milwaukee, and the Borough of Manhattan, equipment repair is done by a bureau (or its equivalent) coordinate with the using agency and in the same major department.

Extent of Responsibility

The amount of equipment for which repair organizations are responsible varies widely, and so does the type of equipment. Philadelphia is the only city observed that has attempted to place responsibility for repair of all city-owned mechanical equipment in one organization. Although the responsibility is nominally with one organization here, actually a large part of the work is being performed in other agencies. Philadelphia also has the largest amount of equipment tributary to a single shop organizations, 6,273 pieces.

In Cleveland, as in Philadelphia, nominal responsibility for repair of all city-owned vehicles and portable mechanical equipment is centralized under one shop organization, but the shop organization is not responsible for installed equipment. The Cleveland organization has only about 1,800 pieces tributary to it, less than the total equipment in Philadelphia's Bureau of Highways and Street Cleaning.

Detroit, Milwaukee, Minneapolis, and Newark have so-called city-wide central repair organizations, nominally for all city departments, but each makes exceptions of some types of equipment; fire-equipment repair is excepted in all. Newark's "city" central repair organization, rather illogically, is a division of a bureau having refuse collection and street cleaning as its major function. Detroit's shop, with 1,800 pieces tributary to it, has the largest responsibility in this group of cities.

The Borough of Manhattan has a central repair organization for borough equipment. Although most of the borough equipment is for highway maintenance, the equipment-repair organization is separate from the agency responsible for highway maintenance.

New York, Chicago, St. Louis, Pittsburgh, and Washington have shop organizations with responsibility solely for repair of sanitation and highway equipment, or one of them. New York's Department of Sanitation has the largest amount of tributary equipment in this group of cities, 3,400 pieces.

Facilities for Repair and Storage

Most of the cities observed are doing their major repair work in central repair shops, are storing vehicles in a few garages where minor repair work is done, and own their own shops and garages. Philadelphia differs on all three counts, since it does major repairs in eight shops, stores in 18 garages, and leases a large part of its facilities.

Major work on wheeled vehicles is done at a central repair shop in nine of the cities observed. Eight cities have separated the repair of track-laying and other heavy equipment from the repair

of wheeled equipment. Every city observed does some minor repair work at its storage garages, but, except in Philadelphia, this is done principally by the shop organization, rather than by the using agency.

Methods of Financing

Nine cities and the Borough of Manhattan, finance equipment repair and replacements by annual appropriations from general funds. Milwaukee operates its shop on a self-supporting basis. The Municipal Equipment Division owns the equipment and charges operating agencies rentals for its use. Rentals go into the general fund, however, and the division is financed from general-fund appropriations. Chicago and Minneapolis also operate their equipment-repair organizations on a self-supporting basis, but rentals go into a revolving fund, out of which costs of overhead and of repair and replacement of equipment are met. Shops on a self-supporting basis also charge for repairing equipment which does not belong to them. Some other shop organizations make a paper charge to account for costs but do not exchange funds.

All cities observed pay for additions to their equipment (as distinguished from replacements), from appropriations from general revenue, although St. Louis and Newark are planning to add equipment by bond issues. Newark is the only city of those observed that is planning to replace equipment with borrowed money. This city is expecting to eliminate its horse-drawn equipment and replace its old mechanical equipment by this means.

Number of Employes

With the great variation in work loads and responsibilities, it is natural that there would be great variations in the number of employes. In general, the shops seemed to have about four to eight pieces of tributary equipment to each person in the repair organization (including overhead workers, but not drivers).

It is difficult to make valid comparisons of pieces of equipment per person employed because of the differences in organizational structure, local union regulations, personnel classifications, and variations in service rendered. However, there seems to be no marked difference between cities having so-called city-wide central repair facilities and those with central repair facilities solely for the using agency. Some astonishing figures are found in the apparent loads in Philadelphia, Pittsburgh and Detroit, with tributary equipment totaling respectively, 26, 17, and 14 pieces per person in the shop organization. It has already been noted, of course, that the shop organization in Philadelphia does not do all the repair. Pittsburgh's Public Works Garage does not do some minor repair jobs. On the other hand a rather noticeable figure is that of St. Louis with only 2.5 pieces per shop person even though there are only 110 pieces tributary to the shop.

Controls on Status of Equipment

Although it would seem desirable to have some report from the shop organization to the operating agency on the status of equipment, none was found in any of the cities studied. Nor was any limit on the length of time equipment was out of service imposed by the head of the department responsible for both shop operations and for refuse collection, street cleaning, and highway maintenance. The practice of "deadlining" vehicles and forcing some

action for repair and replacement, as used by the army, is apparently not feasible in cities, at least not at present, because of parts shortages and old equipment.

In general, the cities rely for control on communication between shops and district offices, or the operating organization maintains its own records of equipment out of service. Although almost all the shop organizations have good records of the action being taken on equipment out of service, this information is not passed on to the using service.

Parts Procurement and Stocking

Although every shop organization observed procures its parts through a central purchasing department, there are wide variations in methods of procurement. Most of the shops are circumventing delays occasioned by central purchasing by such devices as (1) contracts with vendors to furnish parts to shops as they are required, at fixed unit prices, (2) limited-sum open orders for shops to procure parts, (3) procurement, as required, from any source, with confirmation orders following, or (4) maintenance of large shop stocks. It is noticeable that the shop organizations which have the most difficult procurement processes have the largest stocks. Several equipment-repair organization heads stated that they would be unable to operate if they had to get all parts by requisition and central purchase, and several stated that a freer hand on procurement would permit them to leave the storage of many parts to the dealer.

Major assemblies, such as engines and transmissions, are stocked in all cities except St. Louis and Philadelphia. Minor assemblies, generators, carburetors, etc., are stocked to some extent by all shop organizations. Most of them are striving towards greater coverage of standby assemblies where the amount of equipment of one type wll justify it.

Philadelphia and Cleveland both have parts stocked at several shops. All other cities have central stocks of parts with minor stocks at garages. Philadelphia and New York are the only cities where tire storage is not under control of the shop organization.—*The next installment of this article will cover maintenance, repairs, replacement additions and standardization.—The Editors.*

Pre-Cast Concrete Deck for Bridge

A new type of concrete bridge deck, the first of its type in the United States, has been built on a rural road in Dauphin Co., Pa. The bridge is pre-cast concrete, manufactured by a vacuum process, and is reported to be about 25% cheaper than a poured concrete deck. Other advantages are that the use of this method will materially reduce the time a bridge has to be closed to traffic for construction.

A Study of Rural Sidewalks

This report, which was prepared by the Oregon State Highway Commission, presents an account of a study undertaken to provide a means of determining which sections of open road should receive priority in footpath construction to prevent accidents to pedestrians when walking along the road. A mathematical expression for the "index of hazard" on a particular section takes into account the main factors contributing to accidents, such as

volumes of pedestrian and vehicular traffic, condition of verge, width of roadway, condition of light, and speed of traffic. The relative need for footpath construction is given by a formula relating the "index of hazard" to the cost per mile of footpath construction and the number of accidents per mile per year. The formulae have been found of great value in Oregon in correlating several proposed projects of footpath construction and enabling the most urgent to be selected. Technical Report No. 44-3. This item is from *Highway Abstracts.*

County Planning in Monroe County, New York

A County Planning Commission was created in March, 1946, by the Monroe County (N.Y.) Board of Supervisors, in accordance with permissible New York State law. This Commission has control of land use within one mile of any municipally owned airport, and no map subdividing land into lots for residential, business or industrial purposes in such areas can be accepted for filing by the County Clerk unless it is approved by the local municipality and the Commission. Other duties and powers of the commission include: To make and recommend to the Board of Supervisors a master plan for the physical development of the county to cover (1) the general location, character and extent of major and limited access streets or highways; viaducts; bridges; water fronts; boulevards; parks; municipally-owned aviation fields; public parking spaces and grounds; (2) the general location of county buildings; (3) the general location and extent of public utilities and terminals whether publicly or privately owned; (4) facilities for water, light, sanitation, transportation, communication and power; and (5) the removal, relocation, alteration, abandonment, change of use or extension of any of these.

Recommendations made by the Commission must be approved by the affirmative vote of not less than two-thirds of the members, and before recommendations are adopted, there must be adequate notice and a public hearing. The Commission consists of 5 members and 5 ex-officia members.

Water Purification Costs in Monroe

The operating expenses for the Monroe, Mich., water department for the year ending June 30, 1947, amounted to $144.17 per million gallons. Of this amount, $47.97 was for pumping; $16.47 for purification; $11.47 for distribution expenses; $3.86 for commercial expenses (meter reading, collections and vacation replacement labor); $39.33 for general expenses; and $25.07 for depreciation. Norbert F. Yager is Commissioner; Emil G. Munch is chief clerk; and Arthur J. Jennings is City Director.

Village Debts Low in New York

Comparative financial statistics for the 548 villages in New York State have been issued by the State Comptroller. The 548 villages reported a total net indebtedness of $42,753,304, leaving a margin of $137,880,112 on their total debt limit of $166,119,818. Payments for interest costs totaled $1,140,136.85, the lowest figure since 1920. The 1933 peak interest cost on village debt totalled $6,077,546.98.

PUBLIC WORKS DIGESTS

Sewerage

Water Supply

Highways and Airports

This section digests and briefs the important articles appearing in the periodicals that reached this office prior to the 15th of the previous month. Appended are Bibliographies of the principal articles, in which the articles in each periodical are numbered consecutively throughout the year, beginning with our January issue.

The letter and number at the end of each item refer to those used in the Bibliography. Numbers not found in the current Bibliography will be found in the one published the previous month.

The Highway and Airport Digest

Removing Rails From Streets

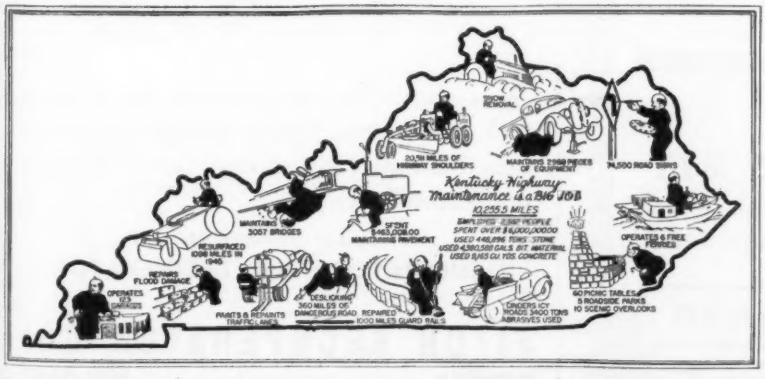
In Memphis, Tenn., 40 miles of street railway track was removed, by equipment designed for the purpose by the contractor, at the rate of 1500 ft. of double track per day, the price being 23 cts per lineal foot for imbedded rail and 11 cts for open track. Removal, cleaning and hauling cost $18 a ton and the rails were sold for $38. The profit was applied to the cost of repairing the damaged streets. This repair consisted of cleaning out the grooves and filling them with asphaltic concrete compacted by means of a rubber-tired motor patrol weighing 20,000 lb., and laying sheet asphalt on this.[L2]

Grass Stabilization Of Sandy Airport

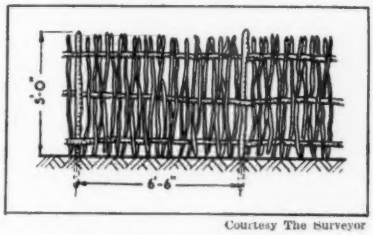
New York's Idlewild Airport was made by depositing over 4,900 acres of marsh 65,000,000 cu. yd. of sand dredged from the bay. The stabilization of this against movement by wind is a major problem. Oil sprayed on cracked and blew away as soon as the volatile oils evaporated, and repeated oiling would be very expensive. The only solution seems to be planting beach grass and poverty grass, 10% of the latter mixed with 90% of the former. Beach grass is planted by machine with tips extending 18" above the ground, which deflect the wind upward. It spreads underground and not by seeds. Poverty grass can be machine-planted only with short stems which do not deflect the wind, but spreads rapidly by seed, forming a mat. Contracts for planting grass have been let at from $125 to $210 per acre. A multiple-row planting machine, adapted from the tobacco planter used in Connecticut, is used.[L3]

Structural Design of Non-Rigid Pavements

An investigation of non-rigid pavement design undertaken as a cooperative project by the Highway Research Board, the Asphalt Institute and the U. S. Public Roads Administration is expected to result in the collection of a large body of important data and, it is hoped, in the development of significant conclusions of great value in connection with the design of bituminous pavements. The principal objectives of the investigation include development of the load-supporting values of non-rigid pavements by full-scale field tests, correlation of these data with laboratory tests to determine whether the latter can be used alone in the design of pavement thickness, and correlation of the data with in-place determinations of various values of the base-course and subgrade components. The article is based on a report in "Public Roads," a publication of the U. S. Public Roads Administration.[O7]



The Kentucky State Highway Department shows, in this illustration taken from the annual report, the many and varied activities of the Division of Maintenance and Equipment.



Courtesy The Surveyor

German type of snow fence.

Snow Fences

Snow fences are in use in most countries where heavy snow falls occur. They may be either solid or open; generally the latter. The slats are vertical in some, horizontal in others. Aperture ratio of 50% appears to be most effective. A gap is left at the bottom of about 6", in most countries—up to 18" in Russia. For horizontal slats the German Road Research Society recommends a fence height of at least 6 ft. with an 8" gap at the bottom. A scissors type is constructed in two sections, in units 6 to 16 ft. long, the slats in the lower section occupying 2/3 of the height of the fence; the two sections being bolted together at an angle of 60° and the fence thus being self-supporting. In Denmark, straw woven into 2" ropes

is used instead of horizontal wooden slats. Of vertical slat fences, the woven wire picket fence is the most popular in this country. Canada and Denmark use a lattice arrangement of 1″ laths. In Russia and Scandinavia a popular type is made by weaving small leafy branches in bands between the posts. Germany uses coco matting with a 2″ mesh, woven branches and sacks or leafy branches tied to wire fences. Swedish investigators concluded that the scissor-type and the woven wire picket are the most convenient types.[D5]

Reconstructing An English Road

In the borough of Sutton Coldfield, several miles of old waterbound macadam that had been tar sprayed three or four times were badly damaged by frost; in many places the crust had entirely disappeared, and what remained in others was only ¼ to ¾ in. thick. To repair them after the war with a minimum of cost, labor and time, the method employed was as follows: The surface was scarified 3″ deep and harrowed, sprayed with bituminous emulsion at 0.5 gal. per sq. yd., and immediately harrowed again, sprayed again at the same rate and harrowed; then rolled with an 8-10 ton roller, then rolled again after 12 to 24 hr. Finally it was surface dressed with a cold bituminous emulsion, 0.25 gal. per sq. yd., and ⅜ in. crushed gravel. For harrowing they used a light spike harrow weighted with old curb stones, a heavy spike harrow, an 8-tooth cultivator and a 3-wheel cultivator. If the surface, after the first rolling, contained voids, these were filled with a thin layer of emulsion and gravel chips, rolled, and covered with granite chips (¼″ to dust) and again rolled. The cost averaged 2 s. 3½ d. per sq. yd.[D1]

Large Trucks Deliver Hot Mix

Work recently done on U. S. No. 1 south of Jacksonville, Fla., consisted of widening the old 20 ft. concrete pavement by 2 ft. on each side and laying a 2″ asphalt pavement in binder and surface course. Heavy traffic had to be kept moving, and one side of the roadway was kept open at all times for alternate N and S traffic, regulated by a flagman. About 1½ to 2 miles of half-width was laid a day, then opened to traffic the next day while the other side was being laid. Because of traffic conditions, the binder was laid for the entire 16 miles of the job before any surface course was laid. The material was mixed at a central plant and hauled to the job, distances up to 10 miles, and dumped, then spread with a finishing machine, a single machine laying as much as 10,000 ft. of 12-ft. lane per day. To minimize delays in hauling and interference with traffic, the hot mix was hauled in five 18-ton dump trucks instead of several times that number of smaller ones. The trucks passed the finisher, then backed up to dump; therefore they could turn empty, a considerable advantage as the shoulders were sandy and narrow.[N1]

Two Pavers Speed Work

In building 5.2 miles of 4-lane concrete road in Cattaraugus Co., N. Y., two 34-E pavers were used in tandem, a dual one in front laying 6½″, followed by a single drum laying 2½″ over the reinforcement laid on the first lift. This plan, combined with supporting equipment that closely balanced each other, is credited with the high rate of laying—an average of 2500 ft. of 12 ft. by 9 in. concrete lane a day, with peaks over 3300 ft.

Four different cements are being used to compare their efficiencies; ordinary Type II portland cement combined with natural cement; the same combined with Daragg Puzzalan cement; the same with nacconal air-entraining agent; and Vinsol resin cement.[N11]

A Big Airport In South Africa

The Jan Smuts Airfield, under construction 17 miles from Johannesburg, will be the largest in South Africa. The main runway will be 10,500 ft. long and 200 ft. wide, and two others will be 8,280 ft. long, each provided with

several hundred yards of "overshoot" at its ends. They will be paved with 4" macadam on a 16" crushed rock foundation. Among the equipment used are Tournapulls, Galion graders, a Caterpillar elevating grader hauled by an Allis-Chalmers tractor, and a Multi-Foote paving mixer with a capacity of 40 tons an hour.[T1]

Winter Accidents

A study by the National Safety Council of winter traffic accidents in four snow-belt states showed that two-thirds of them occurred on snowy and icy surfaces, and a disproportionately large number on county and local roads. A chief cause is the increase in braking distance due to ice; which can be reduced 40 to 50% by use of tire chains —as much as 70% in the case of trucks.

Abrasives are recommended, mixed with calcium or sodium chloride. Cinders were found to be 25% more effective than sand.[X2]

War Surplus Bridges for Highways

The State of California is using war surplus bridges of the portable steel type as permanent highway bridges, having used two to date. One of these is an H-10 bridge 72 ft. long consisting of two structural steel girders, furnished in sections 12 ft. long bolted together. The other consists of two parallel, heavy-type H-20 bridges 125 ft. long with two 12 ft. ramps, supported on concrete piers and abutments.[P3]

Subbases for Rigid-Type Pavements

Subbases are provided to insulate against frost heaves, to furnish additional load support, and to prevent pumping. For the first, porous material a foot or more thick is used. Many question their value for the second purpose; the subgrade should be so thoroughly compacted as to make them unnecessary. For the third purpose, adequate drainage may be a more economical solution. Where subbases are used, some advocate a permeable type, others an impermeable. For the latter, portland cement stabilized soil may be more economical than a rolled graded aggregate, where granular material is expensive.[P4]

Vertical Sand Drains

Four methods have been developed for installing vertical sand drains for hastening compaction of saturated soils. The first was to bore 20" to 24" holes with a rotary bucket and immediately backfill them with sand. The second consists of driving a plugged hollow mandrel, filling it with sand; then closing the top of the mandrel and injecting into it air or water under pressure, which pushes the mandrel up and the sand down. In the third method a hollow mandrel is driven to hard bottom and the hole filled with sand as the mandrel is withdrawn. In the fourth

method the hole is cut with a high-speed rotary bit and a jet, and the slurry is removed from the hole with a pump and the sand is introduced.[N7]

Special Lane For Trucks

A hill nearly a mile long on U. S. 5 in Connecticut with a 7% maximum grade, consisted of two 10-ft. concrete lanes carrying a traffic count of 8,000 a day. Trucks were slowed up on this hill, which resulted in many accidents due to efforts of passenger vehicles to pass them. To remedy this condition, an additional lane for trucks was constructed on the right. This is a 12-ft. width of bituminous macadam adjoining the old concrete pavement, 4,000 ft. long. The lane was built in 1946, and no accidents at this point were reported during 1947.[N9]

Standards for Perforated Pipe

Manufacturers of perforated clay pipe have adopted new standards, providing for ¼" circular perforations arranged 3" c to c in parallel rows; four rows in 4", 6" and 8" pipe, six rows in 10", 12" and 15", and eight rows in larger pipe. No holes are provided in the bottom 90° or the top 200°. Otherwise the pipe is identical with ASTM designations C 13 and C 200.[E2]

Bibliography of Highway and Airport Literature

D *The Surveyor (England)*
December 5
4. The Economics of Motorways. By R. Gresham Cooke. Pp. 633-634.
December 12
5. Drift Control by Snow Fences. By N. G. Lawrence. Pp. 643-645.
December 19
6. Road Location, Construction and Maintenance in Malaya. By T. R. Hutton. Pp. 659-660.

E *Engineering News-Record*
January 8
4. Signs to Speed Traffic. (Overhead Signs on New Jersey Highways.) Pp. 80-82.

I *Municipal Engineering (England)*
December 26
2. Present and Future Developments in the Use and Design of Mechanical Earth-Moving Plant. By J. L. Sturrock and D. J. Simmons. Pp. 348-349.

L *Civil Engineering*
January
2. Improvised Equipment Makes Rail Pulling Profitable. P. 20.
3. Grass Stabilizes Sand on 4,900 Acres of New York's Idlewild Airport. Pp. 34-35, 78.

N *Roads and Streets*
December
7. Sand Piles Hasten Completion of California Expressway. By H. A. Simard. Pp. 51-56.
8. Washington State Putting Radio to Work. By Gordon R. Newall. Pp. 57-58.
9. Extra Lanes for Trucks Cut Down Hazards. P. 62.
10. How High Shoulders Are Trimmed in Kentucky. Pp. 76-77.
11. Twin 34-E's Pave 3300 Lineal Feet of Concrete Road a Day. Pp. 80-83.

O *Roads and Bridges*
December
6. Municipal and Street Railway Authorities Cooperate in Snow Cleaning. By H. D. Bradley. Pp. 62-65.
7. A Study of the Structural Design of Non-Rigid Pavements. By A. C. Benkelman and F. R. Olmstead. Pp. 67-71, 112.

P *Public Works*
January

3. Using War Surplus Bridges. By H. D. Stover. Pp. 19-20.
4. Subbases for Rigid-Type Pavements. Pp. 28, 30.
5. How Much Have Highway Maintenance Costs Risen? Pp. 31, 33.

T *South African Municipal Magazine*
November

1. South Africa's Biggest Airport. Pp. 11, 13, 15, 17.

X *Traffic Quarterly*
January

2. Combating Winter Accidents. By Donald S. Berry. Pp. 53-64.

Measurement of Entrained Air in Concrete

A series of papers on the measurement of entrained air in concrete was presented at the Atlantic City, N. J., meeting of the American Society of Testing Materials. These papers have been bound in a single booklet of 100 pages and is available from the ASTM, Philadelphia, Pa., at a small cost. These papers are summarized below. An introduction by A. T. Goldbeck is also included in which it is stated that: "In recent years no single development in the technology of concrete has approached in importance that of air entrainment." The papers included:

Procedures for Determining the Air Content of Freshly-Mixed Concrete by the Rolling and Pressure Method—Carl A. Menzel, Portland Cement Association. This paper describes apparatus and methods for determining the air content of fresh concrete based on two different principles, neither of which requires weighing scales, namely, Rolling Methods and Pressure Method.

Indiana Method for Measuring Entrained Air in Fresh Concrete—P. D. Miesenhelder, State Highway Commission of Indiana. This paper is devoted principally to a description of the so-called "Indiana Method," for determining the quantity of entrained air in concrete, making use of the relationship between the unit weights of a concrete sample with and without air.

The Measurement of Air Entrained in Concrete—John H. Swanberg and T. W. Thomas, Minnesota Department of Highways. This work was undertaken for the purpose of studying the pressure method for the determination of the air content of plastic concrete. The percentage of air as determined by the pressure method was compared to that obtained by the unit weight method. The work involved the study of three gage pressures and five different aggregates. Good agreement in results among the three gage pressures was obtained.

Comparison of Three Methods of Measuring Air Entrainment in Concrete—Alexander Klein and David Pirtz, University of California, and C. B. Schweizer, U. S. Army. The results of field and laboratory tests on concrete are given as the basis of comparisons of air contents as measured by gravimetric, volumetric, and pressure methods. Following a discussion of the advantages and disadvantages of the methods, brief descriptions of the procedure of testing are given, with certain modifications adopted at the University of California.

Measurement of Air Contents of Concrete by the Pressure Method—H. W. Russell, Illinois Division of Highways. Since several sources of error are known to exist in the method of determining air contents of concrete on the basis of weights of samples of known volume, it is desirable that a more satisfactory method be developed. Most of these sources of error do not exist in the pressure method. An apparatus for use in determining air contents of concrete by this method has been constructed, designed for a test pressure of 15 psi., eliminating, as far as possible, all detached accessories.

Analysis of Methods of Measuring Entrained Air in Concrete—W. A. Cordon and H. W. Brewer, U. S. Bureau of Reclamation. Determinations of the percentage of air in 45 batches of laboratory mixed concrete by the gravimetric, pressure, and displacement methods show what accuracy might be expected from each method. Errors which might occur in each method are discussed.

When you need special information—consult the **ENGINEERS' LIBRARY** *on pages 77-81*

The Pycnometer Method for Determining Entrained Air in Concrete —J. C. Pearson, Lehigh Portland Cement Co. This paper reviews briefly the development of the pycnometer test for entrained air as a basis for Tentative Method C 173-42 T and the more strictly volumetric method described in the report of Committee C-9 on Concrete and Concrete Aggregates for 1944.

The Ohio Method of Determining the Amount of Air Entrained in Portland Cement Concrete—J. F. Barbee, Ohio State Highway Testing and Research Laboratory. While the Ohio Highway Department has specified air-entrained concrete in its pavements since January, 1943, and in its structures since March, 1945, it was not until March, 1946, that the specifications were altered to require that a definite percentage of air be entrained. This paper describes volumetric Hook gage method, and comparative tests.

The Effect of Sampling Errors on Unit Weight and Air Determinations in Concrete—J. C. Pearson and S. B. Helms, Lehigh Portland Cement Co. If a test sample from a batch of freshly mixed concrete is taken for analysis the chances are that the ratio of coarse aggregate to mortar in the sample will not be exactly the same as that in the batch. The excess or deficiency of coarse aggregate in a nonrepresentative sample is arbitrarily called the sampling error, and a method for evaluating this error and its effect on computed unit weight and entrained air is given in detail.

A Selected Bibliography on Highway Safety

This 46-page bibliography was prepared at the request of the National Committee for Traffic Safety, and contains an annotated listing of selected references in highway safety. Although the scope of the bibliography is confined to highway safety, many items dealing with matters of design, construction, and traffic facilitation are included because they have a direct bearing on safety.

The bibliography was compiled by the Committee on Highway Safety Bibliography of the Traffic and Operations Department of the Highway Research Board with the assistance of the library staffs of New York University Center for Safety Education, Northwestern University Traffic Institute, Yale Bureau of Highway Traffic, Public Roads Administration, and Highway Research Board. Single copies are priced at 45 cents each. Special prices for quantity lots will be furnished on request to Highway Research Board, 2101 Constitution Avenue, Washington 25, D. C.

Construction and Maintenance of Equipment

An Ingenious Stock-Pile Truck Loader

This loader operates without the truck driver leaving his seat; and without any power take-off or outside power. The traction of the truck's rear wheel on the treads of the loader operates a lever mechanism. The only equipment needed on the truck is a hitch, which can be installed in 8 hours; and any number of trucks, with the hitch installed, may be used with the same loader. It is stated that a 3-yard body can be loaded in 3 minutes. Recommended for loading grit for sanding or cindering roads; also, with a larger bucket for snow removal. Write the *Shoveller Corp., Portland, Me.*

Vibrating for Pavement Bases

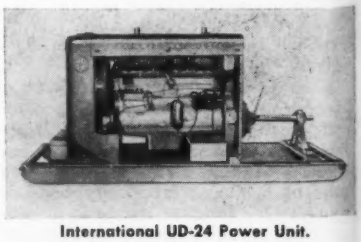
Vibration can be made to force fines down into coarse aggregate for base construction of highways. After the coarse aggregate layer is shaped, fine material is placed on top and the Vibro-

Vibrator on road compaction.

Tamper used to produce an unusually compact base. There are six vibrating shoes, each 16 ins. long, giving a width of 8 ft. This strip is compacted in two or three passes, according to the manufacturer. The machine is self-propelled and operates on crawlers. Vibration speed is 2,800 to 3,000 per minute. Write *International Vibration Co., Waterloo Road, Cleveland 10, Ohio.*

Biggest International Diesel

The UD-24 has a developed horsepower of 191 at 1,375 rpm. It is a 6-cylinder, 1,090-cu. in. diesel with a 5¾"x7" bore and stroke. It is suitable



International UD-24 Power Unit.

for construction machinery, electric power plant work, rock crushers, and similar installations. Full data from *International Harvester Co., Industrial Power Division, 180 N. Michigan Ave., Chicago, Ill.*

Jaeger Diagonal Screed Paving Finisher

This labor saving tool has many advantages in pavement finishing. On super-elevated curves, the angle of the rear screed carries the material uphill and compacts it solidly, eliminating the need for carry-back, especially when using stiff mixes, thus eliminating one or two shovelers. Accuracy is improved by the operation of the rear screed diagonally to the front one. Irregularities are reduced, as is the amount of accompanying hand work. On harsh, dry mixes, this finisher is claimed to work without "tearing" the surface, again eliminating the need for extra work. This is the "X" Finisher. Full information from *Jaeger Machine Co., Columbus 16, Ohio.*

Jaeger diagonal screed.

A 1-hp. Vest-Pocket Size Engine

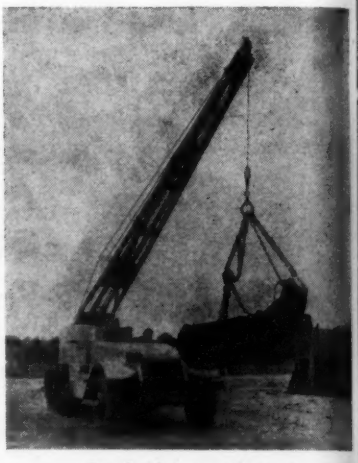
Here is an engine, weighing only 16 pounds, and only 14 inches in the largest dimension (8½ ins. in the smallest), which develops a full horsepower. It is an aluminum, vertical shaft unit which will operate at any tilt up to 45°. A 1½-2 horsepower unit is scheduled for early production. Lots of uses for this little engine. Full data from *Power Products Corp., Grafton, Wisc.*

For Better Control of Cinder Spreading

A declutching device is now available which permits the driver to start and stop both the drag chain and the distributor or spinner of sand, salt and cinder spreaders. Hills and curves can be cindered to just the right distance and the right width, without waste of material which may be hard to get during a storm; and the saving in material itself may be important. This declutching device is made up into a standardized kit which can be shipped out for installation on spreaders already in service. For fuller information and illustrated folder, write *Baughman Mfg. Co., Jerseyville, Ill.*

Half-Track Lugger Crane Can Save Money

The "Lugger Crane" is mounted on a half-track, and will lift and carry up to 6,000 pounds. Operation is simple. The mobility and capacity of this crane should make it valuable for pipe handling into trenches, lifting hydrants, pumps, tools and equipment for highway work, and many similar jobs. Speeds up to 40 mph.; operates in any kind of terrain. *Day-Smith Hydraulic Crane Corp., Camp Hill, Pa.*



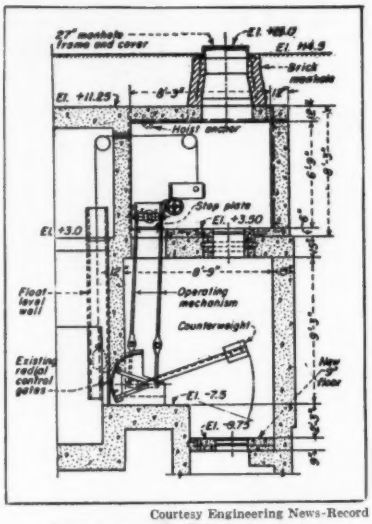
Day-Smith Lugger Crane.

The Sewerage Digest

Automatic Control Of Diversion Chambers

The Chicago Sanitary District contains 178 miles of intercepting sewers, on which are a great number of diversion chambers to control the amount of storm water that flows to the treatment plant. The gates in these chambers at times become blocked by debris, which condition may not be detected for some time. To remedy this, a system of supervisory-operated control structures was designed, by which control gates are opened and closed from a central operating station, where positions of gates in motion and at rest are registered on indicating meters, and water levels in the control structures are indicated continuously. These controls will provide calculation of the quantity of flow through the gates; adjustment of the gates to the desired flow; diversion of all or any portion of the flow; observation of any abnormal condition in the control structure such as rainfall in any area or a blocked control gate; clearance of a blocked control gate by opening and closing the gate; and diversion, by gravity instead of pumping, of large quantities of storm water, resulting in a saving in pumping costs.

One of these control structures is in operation and plans are being made for installing 15 more.[E4]



Courtesy Engineering News-Record

Remote control of diversion gates.

Chlorination of Cyanide Wastes

Free cyanide is one of the most toxic components of industrial wastes that are often discharged into sewers and streams. It is very toxic to fish, as little as 0.1 ppm having proved fatal; and from 0.1 to 0.3 gram of CN is fatal to humans. Received at sewage plants, it not only interferes with both aerobic and anaerobic processes but application of chlorine may produce extremely noxious gases. Several methods of treatment by acidification have been employed but all leave a substantial residual of cyanide, increase the pollution load, and none is applicable to the treatment of dilute wash solutions such as are obtained from plating operations. Chlorination of solutions at pH above 8.5 has now proven to be an economical and satisfactory method. It may be employed by either batch or continuous treatment, the former preferably for small plants; this treatment being applied to the waste before it is discharged into the sewer. Summing up, the author says:

"The application of chlorine for the oxidation of the highly toxic cyanide radical to form cyanates or carbon dioxide and various oxides of nitrogen is now a proven process, having been verified by extensive laboratory tests and several plant installations over a period of years. The overall method is competitive in cost with any other method that has been previously suggested for the disposal of cyanide, and has the advantages of being cleaner, easier to operate, and of producing an effluent which is vastly superior."[C6]

Combined Sanitary Sewer and Drain

Lander, Wyo., population 4,000, is located in a valley where the soil is sand and gravel to an unknown depth, always saturated with water causing wet cellars and frost heaving in the streets. In 1946 it built a sanitary sewer system in which the top half of each joint was left open and the trench back-filled with gravel for 18" above the pipe. The bottom half of the joint was made with asphalt and oakum. The sizes of pipe were designed to drain out of the ground 6" of water per day over the entire area served by the sewer. Now all buildings within half a block of a sewer have dry basements and frost heaving in the streets over the sewers has been eliminated. The sewers include 2300 ft. of 24"; 2300 ft. of 21"; 1700 ft. of 18"; and 29,000 ft. of 15" to 8" sewer.[P5]

Relining an Old Brick Sewer

West Racine, Wis., has recently saved a 50-year old 2-ring brick sewer 66" diameter from collapse by lining it with Armco asbestos-bonded paved pipe. Longitudinal cracks had resulted in some deformation of the sewer so that 60" pipe was the largest that could be inserted. The pipe was inserted in 12 ft. lengths through an opening in the sewer 20 ft. long, and rolled to place by means of a special dolly or carriage. The successive lengths were joined together by means of 24" coupling bands. The space between the old sewer and lining was filled with grout forced into place with a pressure grouting machine operated from the surface through holes 50 to 75 ft. apart. The flow of sewage was uninterrupted during the construction.[P6]

Gas Fires in Sanitary Fill

San Francisco's garbage, now averaging 830 tons a day, has been disposed of in a sanitary fill for 15 yr. on a deep mud bottom along the bay front. It has settled into the mud 30 to 40 ft. although standing only 18 ft. above the mud line. In settling, cracks have opened in the face through which air has entered and spontaneous combustion has taken place due to the presence in the fill of rapidly oxidizing materials such as paints and linseed oil. Flames issue from the cracks, but of such low temperature as to char wood very slowly. The gases formed are found to consist of approximately 25% CO_2, 60% methane and smaller quantities of hydrogen and nitrogen. It is impracticable to reach the burning interior with water, but the fire can be smothered by covering the cracks with earth to shut off the supply of oxygen.[E7]

Tunneling a Deep Sewer

In placing 11,700 ft. of 45" and 48" sewer from 40 to 100 ft. below the surface in Cuyahoga Heights, Ohio, in unstable ground subject to pronounced tremors from forge hammers, freight trains and other surface loads, the contractor employed tunneling, placing the sewer pipe in a 6 ft. tunnel. As the pipe was to carry some pickling liquor, it was made of reinforced concrete lined with de-aired vitrified plates, cast monolithically with the pipe, and joints between these plates and between the pipes were filled with an acid-resistant compound. In tunneling, steel liner plates were used instead of poling boards as being safer and more economical. Each 5-ft. length of pipe rested on two precast concrete blocks in the tunnel, and the space between pipe and tunnel liners was filled with brick set in mortar, with concrete pumped into place, or a cushion of graded slag or gravel. All spaces outside the tunnel liners were pumped full of cement grout under pressure of 30 psi. In a few stretches, compressed air at 13 psi was used to exclude water from water-bearing sand above.[E5]

Original Woodcut by Lynd Ward

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Heating Covered Sludge Beds

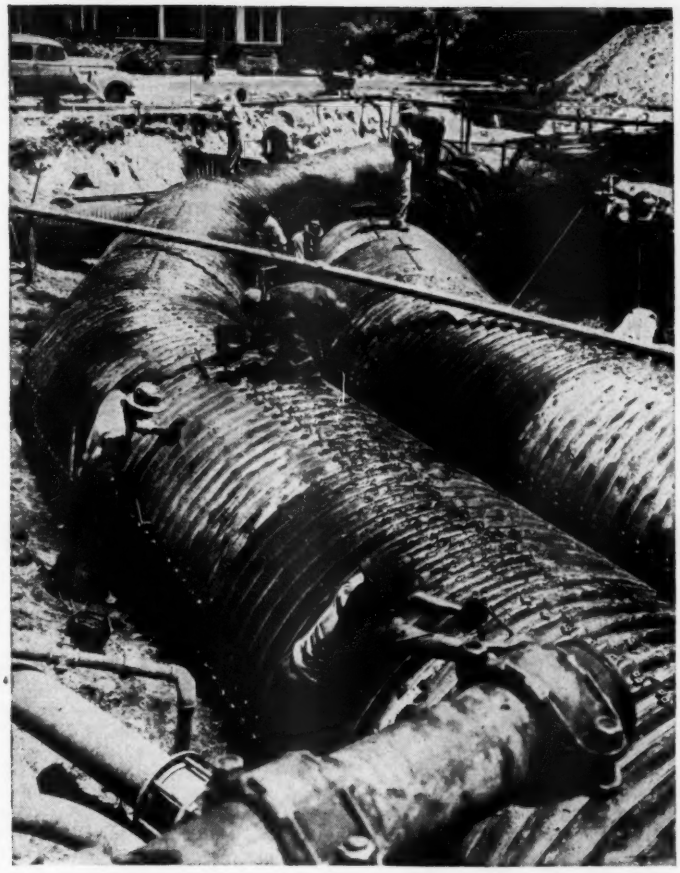
From calculations, including consideration of the humid heat of air, air temperature, heat of evaporation of water, temperature and specific heat of the sludge, radiation and conduction losses, and solar radiation, the author calculates the cost of heating glass-covered sludge beds and the savings effected thereby. Under several assumed conditions, he finds the cost of heating to be 6% to 25% of the saving in capital investment; and that therefore heating is justified under only exceptional circumstances where high land values, expensive construction or lack of space for further plant expansion would necessitate more costly sludge disposal methods.[G6]

Seasonal Filtering and Chlorination of Effluent

The sewage of Hales Corners, Wis., is treated in a plant with a design flow of 140,000 gpd average and 360,000 gpd peak flow. It flows by gravity to a pumping station, where it is lifted 65 ft. to an 8" c.i. force main 5,500 ft. long which conducts it to the treatment plant. To prevent the accumulation of gas at summits in the force main, a vent is placed at each summit discharging into the collecting sewers. The plant contains two primary tanks, a standard-rate trickling filter, and a final settling tank, with provision for recirculation of its effluent to the primary tanks. During the summer, final tank effluent is placed on 4 intermittent sand filters with an average loading of 610,000 gpad, which are followed by chlorination. The sand filters and chlorination are not used in winter, but are used in summer because the creek receiving the effluent flows through ponds in the county park system and is used for swimming. The B.O.D. of the effluent is normally lower than that of the creek above the plant, averaging 5 ppm in summer and 9 in winter.[H6]

Sewers Damaged By Sulfation

During the past ten years sewers at Birmingham, England, have been found to be suffering from disintegration of the cement in brick work and pipe joints. The 3:1 mortar in the brick joints is reduced to a sandy paste and the brick work distorted by its expansion. Analysis of the ground water and of the deposits on the sewer showed strong concentrations of sulfates. The source of the sulfates has not been established; it may be leached from patches of gypsum known to exist in the soil. The Building Research Station states that if sulphur trioxide in the water is below 300 ppm the risk of damage is slight; from 300 to 1,000 ppm, pozzolanic or high alumina cement should be used; if the concentration exceeds 1,000 ppm the risk of damage is serious and only high alumina cement should be used. In any case the mortar or concrete should be dense, using an excess



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of fine aggregate. Also it is recommended that no dolomite be used as either fine or coarse aggregate.[D3]

Sewage Treatment At San Francisco

The Richmond - Sunset plant, at Golden Gate Park, for treating part of San Francisco's sewage was put in operation in 1939, and is now being enlarged to meet requirement until 1970 by adding two new mixing tanks and two sedimentation tanks. With these, there will be 5 min. pre-aeration for grease flotation, 23 min. mixing period and 1.08 hr. detention in the sedimentation tanks for a flow rate of 20 mgd. Water spray skimming has proved so satisfactory that it will be installed in the new tanks; consisting of cross lines of pipes at intervals of 15 ft. 9 in. with nozzles at intervals of 3 ft. 3 in., set 1 ft. above water level, connected to a header along the side of the tank. These drive the scum into one corner of the tank, where it is removed by means of a scum trough. Sludge is pumped to thickening tanks, which receive the scum also; from which, after settling, the solids from bottom and surface are pumped to the digestion tank and the middle portion is returned to the sewage inflow.

The present digestion tank has such inadequate capacity that the contents have a moisture content higher than the freshly introduced sludge and the entire contents are filtered on a vacuum filter after elutriation. A larger digestion tank is being added which will give 0.95 cu. ft. per capita capacity in the primary tank and 0.5 cu. ft. in the secondary; equivalent to 60 days holding capacity. Provision is being made for single-stage elutriation of the primary sludge before its introduction into the secondary tank. It is planned to dehydrate the sludge for use as fertilizer.

The plans for the North Point and Islais Creek plants were described briefly in the August *Digest*. A detailed description is given in this paper. Air will be removed from the sludge treatment plant through a 200-ft. stack together with exhaust gases from the dryers. A pre-aeration compartment will be formed in each sedimentation tank by a cross baffle wall extending down from a point just below normal water surface to just above the sludge collectors, and air supplied at from 0.05 to 0.10 cu. ft. per gal. through vertical porous plate diffusers. A tilting trough skimmer on top of the baffle wall will permit skimming from each compartment.

Sludge cake from the filters will be flash dried to 8% moisture by means of digestion tank gas, and conveyed to overhead concrete bins having a week's storage capacity, the bottoms of which will be occupied entirely by a system of power-driven conveyor screws arranged to form a so-called "live bottom" to prevent the sludge from arching or hanging up when being withdrawn.

A special plant will treat the excess moisture from thickening, digestion tank supernatant, spent elutriate and vacuum filter filtrate, all combined; with violent mixing and aeration in two tanks and sedimentation in two others. The aeration period will be 2 hr. with air applied up to a maximum rate of 1 cu. ft. per gal.; the sedimentation tanks will give 2 hr. sedimentation and the sludge will be pumped to the digestion tanks.[C1]

DDT As Insecticide Around Sewage Plants

DDT is a useful insecticide around the sewage treatment plant. The use of 5% DDT emulsion, added to the influent to trickling filters at the rate of 1 ppm, will effectively control filter fly larvae. No detrimental effect to filter growth will result. Care should be taken to keep the concentration of emulsifying agent at a minimum.

The use of 5% DDT sprays, either in kerosene or as an emulsion, can be used effectively to control adult filter flies, house flies, mosquitoes and other insects. Dosage should be at the rate of 1 quart per 250 sq. ft. For the control of house fly larvae, DDT alone is not sufficient. It should be dissolved in diesel or fuel oil.

Where mosquito breeding is observed at the sewage plant, 10% DDT dust can be used to obtain a residual kill,

when applied at the rate of 10 lbs. per acre.

The DDT solutions or emulsions used can be purchased ready-mixed for approximately 45 cents per gallon, 5% basis, or can be mixed at the plant at a small saving.[H9]

Natural Purification By a Shallow Stream

Experience has indicated that some of the principles of natural purification applicable to a deep, relatively sluggish stream like the Ohio do not apply to a shallow, turbulent stream. An unusually careful and complete study was made of a stream section 42.7 miles long, of which about 25% is riffles or rapids and 75% is shallow pools which average 3.6 ft. deep at low-water stage. The average velocity during this study was 0.70 ft. per second. At the upper end the stream had 4.8 ppm B.O.D., 5.34 ppm D.O., and an MPN of 4,100 coliform organisms per 100 m.l. Within the first three miles the sewage from 28,000 persons and industrial wastes contributed 72,450 lb. per day of 5-day B.O.D. This would have increased the B.O.D. of the stream to 26.3 ppm if added at a single point, but natural purification reduced it so rapidly that the maximum observed value anywhere was 20.6 ppm.

Some of the conclusions reached from this study are as follows:

The rate of reduction in B.O.D. was much more rapid in this stream than in the usual deep, sluggish stream. The reduction was about seven times as great for 0.5 day and four times as great for one day.

The rate of first stage B.O.D. reduction in the stream water followed the normal course of bacterial death rates. This indicates that the rate was not constant but diminished progressively with time below the entrance of pollution.

It is suggested that the rapid reduction in B.O.D. may be due partially to the absorption of organic material in biological slimes on the bed of the stream.

The assumption that all deposited material exerted its full potential demand on the dissolved oxygen of the stream water resulted in obviously excessive reaeration coefficients k_2 that ranged from 15.52 to 5.22 at 20° C. It is suggested that portions of the deposited material may have decomposed anaerobically and escaped from the stream as unoxidized gases, without utilizing oxygen from the stream water.

Only one stream section yielded a calculated reaeration coefficient that is believed to represent accurately the reaeration capacity of the section. This value, 0.684 at 20° C., was obtained in a section with more riffles and a higher velocity than the averages for the stream. A more nearly representative average for the entire stream possibly would fall between 0.5 and 0.6.

This stream could assimilate more organic pollution without excessive dissolved oxygen depletion than could a deep sluggish stream. Some of the factors that affect the assimilative capacity appear to be:

(a) High reaeration coefficients that increase the assimilative capacity.

(b) Concentration of B.O.D. through deposition on the bed of the stream, which tends to decrease the assimilative capacity.

(c) Elimination of a portion of the deposited material without utilization of dissolved oxygen, which tends to counteract the concentration of B.O.D. and increase the assimilative capacity.

The coliform death rates for this stream were similar to those for the Ohio River, but were higher immediately below pollution and lower farther downstream. After 10 hours only 2.5 per cent of the coliforms remained, compared to 64 per cent in the Ohio. After 100 hours comparable values were 1.1 and 1.4 per cent.[C8]

Lime in Treating Acid Wastes

Acid wastes can be treated most economically if the pH is reduced by means of an alkali, for which purpose lime is the most easily handled and generally the cheapest material. Lime increases the amount of sludge and makes it sticky, slow-drying and difficult to dis-

pose of; but several processes are being developed, including the "Fluo-Solids," for drying the sludge and reclaiming the lime. Approximately the following amounts of lime are recommended per 1,000 gal. of waste: Acid mine wastes, 30 lb.; textile wastes, 2 to 4 lb.; gas house wastes, 5 lb.; cannery, 1 to 2 lb.; creamery, 3 lb.; pickling liquor, 25 lb.; corn products, 11.7 lb.; packing house, 8 lb.; distillery wastes, 58 lb.[H8]

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4. Grease Traps for Kitchen Wastes. By L. B. Escritt. Pp. 631-632.

December 12

5. Sewage Purification (in England). By F. T. Hambleton. Pp. 649-650.

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6. Random Reflections on Sewage Purification. By John Hurley. Pp. 655-658.

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7. Large-Scale Experiments on the Sedimentation of Sewage in Rectangular Tanks. By S. H. Jenkins, C. H. Hewitt and C. E. Winsor. Pp. 669-670.
8. Future Sewage Purification Problems at Bradford. Discussion of D2. Pp. 673-676.

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5. Mining a Deep Sewer in Unstable Soil. Pp. 70-73.
6. Refuse Disposal Practices Analyzed at Michigan Public Health School. Pp. 77-78.

January 8

7. Gas Fires in a Sanitary Fill. Pp. 86-87.
8. Rotating Drawoffs for Sludge Liquor. Pp. 93-94.
9. Refuse—In and Out of the Incinerator. By Henry W. Taylor. Pp. 100-103.

G *Water and Sewage Works*
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4. Responsibilities of Water and Sewage Works Operators. By Francis S. Friel. Pp. 435-438.
5. Pulp and Paper Mill Reduces Pollution of Clarion River. By Christian L. Siebert. Pp. 449-451.
6. Cost of Heating Glass-Covered Sludge Drying Beds. By Albert B. Kozma. Pp. 456-462.

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6. Sand Filters and Chlorination Used Seasonally at Small Plant. By J. A. Strand. Pp. 14-16.
7. Design and Operation of Modern Incinerators: Providence, R. I. By Henry W. Taylor. Pp. 17-18, 34.
8. Lime for Industrial Waste Treatment. By Edmund B. Besselievre. Pp. 19-20, 26.
9. DDT Emulsion May Damage Filter Growths. By R. W. Simpson. Pp. 23-24.
10. The Use of Chlorine for Odor Control. Pp. 29-30.

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4. Experimental Work Leading to an Increased Efficiency in the Bio-Aeration Process. By J. H. Edmondson and S. R. Goodrich. Pp. 334-336.

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4. Sewage Treatment Results at Fort Wayne. Pp. 21-23, 41.
5. Sanitary Sewer System Designed to Lower Ground Water Level. By G. H. Brodrick. Pp. 26-27.
6. Lining Gives a 50-Year-Old Sewer a New Lease on Life. By William Chadwick. Pp. 32-33.
7. Paving and Sewer Costs. Pp. 34-35.

Y *Contractors Record*
December 24

1. Sedimentation: Theoretical Considerations. By L. B. Escritt. Pp. 13-16.

Sewerage Publications

Clarifiers and Filters.—A 32-page booklet describes Spiraflo clarifiers and aerofilters. This is a fine text on the design of aerofilters and contains a good deal of enginering data. The curves shown are essentially those contained in the June, 1947, issue of PUBLIC WORKS, but are larger and clearer. It discusses the use of special tile media. Four pages are devoted to a description of the Spiraflo clarifier and results obtained by it. See also Nov., 1947, PUBLIC WORKS. This booklet can be obtained by writing Lakeside Engineering Corp., 222 West Adams St., Chicago, Ill.

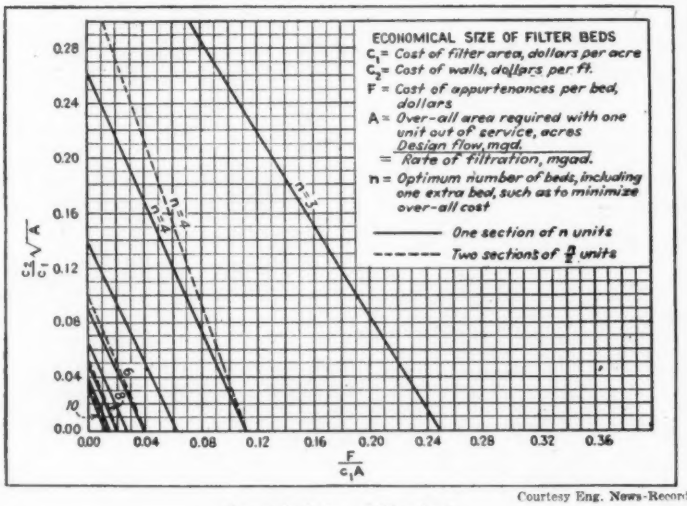
Facts About Stream Pollution.—An instructive 4-page folder briefly describes equipment for alleviating stream pollution. Hardinge Co., York, Pa.

Handling Supernatant Liquor Problems.—A fine booklet on a difficult problem; 8 pages; 3 full-page diagrams. A device installed in the tank extends up through the various strata or levels; a straining action selects the proper supernatant for return. This booklet describes the equipment and the procedures. Ask for Bulletin 343. Pacific Flush Tank Co., 4241 Ravenswood Ave., Chicago 13, Ill.

The Water Works Digest

Economical Sizes of Filters

The author has developed formulas and a graph for calculating, for a given plant, the number of filters, sizes and dimensions which will give the minimum cost of construction; including valves, rate controllers and other appurtenances, and providing for stand-by filters and future extensions. The variables involved are cost per acre of the bed itself, cost of walls per lin. ft., cost of appurtenances per unit, width and length of a unit, number of units, and total filtering area required. The calculation applies also to other rectangular beds—sand filters, sludge drying beds, etc.[E1]



Courtesy Eng. News-Record

Economical size of filter beds.

Bromine for Pool Disinfection

In Illinois, 39 swimming pools use bromine as a disinfectant, in dosages varying from 1.0 to over 4 ppm (based on pool volume), between 2.00 and 2.99 ppm in the majority of cases. Reasons given for preferring bromine to other disinfectants were: equipment was simpler and required less attention, fewer eye-irritation complaints, better bacteriological results, and the maintenance of more constant residuals, and that bromine was safer to handle and reduced algae more effectively than other disinfection.[E3]

Removing Iron And Manganese

There is no single method that is satisfactory for the removal of iron and manganese in all cases. Individual study is required in each case to decide the most economical design of plant to accomplish the desired result. Frequently, the installation and operation of field pilot plants is the safest procedure.

The analysis of the water is the most important factor in determining this design. Hard waters, low in organic matter, and containing medium amounts of iron and manganese can be handled by simple pressure aeration and filtration. But when the water is low in hardness and contains high amounts of CO_2 or organic matter, it is necessary to precede the final filters by contact filters and frequently chemical pretreatment is required in addition. Sludge blanket units will probably in the future take the place of contact filters in most instances.

Manganese zeolite is very valuable as a finishing or polishing process because it reduces the iron and manganese to under 0.1 ppm. It is particularly efficient in manganese removal.

Free residual chlorination offers a means of manganese removal at costs comparable to or less than other chemical treatments although the latter have been found effective in some instances.

Where water softening can be combined with iron and manganese removal, lime treatment at high pH values required for softening automatically eliminates the iron and manganese very completely.

Where the iron and manganese are present as ferrous and manganous cations respectively, sodium zeolite (by base exchange) is a very efficient method of removing both the hardness and the iron and manganese as long as no air enters the water before it reaches the zeolite.[G5]

Removing Fluorides

Methods utilizing the exchange properties of apatites, such as bone, ion exchanges, and aluminum compounds, are those most promising for removing excess fluorides. Where the fluoride concentration is less than 4 ppm, processes used for removing magnesium are indicated. Tricalcium phosphate used in contact filters is one method. Aluminum sulfates and other aluminum salts have been used. The lime softening process, tricalcium phosphates and resinous ion exchangers used in contact filters seem to be the most practicable.[X5]

Discharge Over Submerged Weirs

Submerged weirs have the advantage over those not submerged that they conserve elevation, but they are seldom used because of lack of design and performance data. Investigations at the hydraulic laboratory of Pennsylvania State College have been undertaken to develop design and performance characteristics for all common shapes of sharp-crested and broad-crested weirs. The types of weirs tested were the symmetrical proportional, the rectangular both full-width and contracted, parabolic, 90° triangular, and cusp parabolic. It was assumed that the flow is the difference of the free-flow discharge due to the upstream head above the weir (h_1) and that due to the downstream head (h_2): these discharges being indicated by Q_1 and Q_2. The head h_1 is taken at least $4h_1$ upstream, and h_2 6 to 10 ft. downstream.

From 280 tests there was developed the formula $Q = Q_1 (1\text{-}S)^{0.385}$, in which $S = \frac{h_2}{h_1}$, which applies to all sharp-crested weirs. The formula gave more accurate results with triangular and parabolic weirs than with proportional and rectangular.[E2]

Rapid Pipe Laying

Giddings, Texas, several years ago found it necessary to lay several miles of water mains as speedily as possible, using cast iron. Calking oakum and lead was time-consuming, and after trying rubber ring gaskets and lead on one street with satisfactory results, followed by rubber gaskets and "Mineralead" on a second street, the rest of the work was completed using these materials, saving practically all the time required for calking, and much of the cost of lead.

Fire trucks pumping on small mains had caused leaks in the old mains, but did not in these. Joints made with Mineralead sometimes leaked for several days, but not if the pipe line was covered as fast as the joints were made, thus maintaining their temperature and length constant. Four men easily lay 350 ft. of 8" main in a day by this method.[P4]

Reconditioning Old Cast-Iron Pipe

During the past year, Los Angeles, Calif., has reconditioned 16,000 ft. of cast-iron pipe removed from its streets. The trench excavation is by machine down to the pipe, completed by hand; the pipe is lifted by a crane, the lead joints melted by oxy-acetylene torch, and the pipes taken to the yard. There they are scraped and grit-blasted to a foundry-fresh condition and lined with a 50:50 mixture of cement and sand. This is applied by the extrusion process uniformly over the entire inner surface as the pipe is revolved very slowly; and the speed is then increased to a peripheral velocity of 1,500 fpm. For curing, the ends of the pipe are capped to retain the moisture, the lining being wet twice daily for two days. The outside is given a thin coat of a coal-tar base paint.[E4]

The Second Mokelumna Aqueduct

The original Mokelumna aqueduct, which was laid in 1929, is being paralleled by another to meet increased consumption demands. The latter contains 30 miles of 67" and 68" pipe. Steel is being used as in the original aqueduct, but is lined with cement instead of asphalt enamel, and coated with cement rather than felt wrapping; also the field joints are being welded, while riveting was used for the first line. Bids for concrete pipe also were received, but the lowest for this was $6,879,950 as compared to $6,461,155 for steel. For the field welding, 34 electric welding machines are being used. The lining is placed centrifugally, for which some new details are necessary because of the unusual size of the pipe. The mortar coating is sprayed with great force against the outside of the pipe, which is first wrapped with a ¼" rod under 500 lb. tension; the mortar having only 0.37 parts of water to 1 part of cement.[E5]

Erosion Control in California

Los Angeles, Calif., obtains its water supply from watersheds extending as far as 350 miles from the city, some of them covering several thousand square miles. Control of erosion on them would be impracticable, but diminishing the silting of reservoirs is effected by various devices. On the Owens river aqueduct, silt and sand are trapped at several points along 60 miles of open aqueduct. At points where cloudbursts would wash silt into the aqueduct from the hillside above, overhead crossings or sluices carry the storm water across the aqueduct. Sixteen debris basins held back 690,000 cu. yd. of material during the flood of 1938. More or less organic material has been washed into one basin and covered by silt, and carbon dioxide gas was formed. One solution is to construct around a reservoir a bypass channel to carry flood waters from storms of sufficient intensity to cause considerable erosion. Such a channel also could intercept drainage from a residential community, should one develop there later.[A9]

In the East Bay Municipal Utility District, the chief erosion problem exists on its local watersheds. Up to the present time 105 erosion control structures have been built, each one for the purpose of stabilizing the profile of a gully or channel, to permit the growth of vegetation which will hold the soil in place. These structures include 20 Missouri-type dams with drop inlets; 20 rubble masonry check dams; a reinforced concrete overfall dam; 46 road culvert structures, some with risers and some with transition inlets and outfall aprons; and 18 miscellaneous structures. It is estimated that these have trapped 50 acre-feet of debris in five or six years.

The Missouri-type dam consists of an earth fill across the gully or channel, covering a corrugated metal pipe culvert with a vertical riser on the upstream end to provide a silting basin above the

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dam. A trash rack is placed upon the top of the vertical riser to prevent clogging and also to eliminate the vortex action of the water when the pipe is discharging under a maximum head.

A stop structure for gully control is constructed of rubble masonry and has a stilling basin at the foot of the drop to prevent scour, sometimes supplemented by longitudinal sills in the stilling basin.[A10]

Disposal of Brine From Zeolite Softeners

Wastes from sodium zeolite treatment plants contain unused salt plus chlorides of calcium and magnesium with small amounts of various compounds of iron and manganese. These cannot be removed readily by ordinary water treatment methods. There is now no method available for removing salt wastes from water that is practicable for use on a public water supply. If discharged into a sewer system in slugs, these wastes may seriously upset biological treatment of the sewage; and slugs of them in streams may destroy fish.

Four methods of disposal are discussed—evaporation ponds, which are seldom satisfactory; uncontrolled discharge into streams, which is the simplest method but the amount of dilution water must be adequate at all times; controlled discharge, the brine wastes being stored in reservoirs and discharged from them into stream or sewer at rates that can be diluted sufficiently to render them harmless; and by discharging them into the ground through brine disposal wells, which is considered impracticable except under very unusual circumstances.

Controlled dilution appears to be the most generally applicable method, but even this is unsatisfactory unless ample dilution water is available.[A7]

Disposal of Lime-Soda Sludge

There are four general methods of handling softening plant sludge; lagooning; discharge into a stream; drying and use in agriculture or as a filler in paint and many other manufactured articles; and calcining it to recover the lime for re-use in softening. The great majority of plants use the first, which requires about 0.00211 acre-feet of storage space per m.g. of water softened. The second is possible only for plants on relatively large water courses, and the present tendency is toward the prohibiting of this by law. As to the third method, dewatering and drying processes are entirely satisfactory and can be used by relatively small plants.

The fourth method looks most promising, and usually produces more than enough lime for use in the softening process. Three calcining plants, each using a different process, will be in operation in 1948 or 1949. The Hoover and Lykken-Esterbrook processes prevent the building up of the undesirable magnesium in reclaimed lime; the third process is a physical separation of the

magnesium hydroxide from the calcium carbonate in a centrifuge during the dewatering of the sludge.

The rotary kiln has long been used for calcining, but is hardly practicable for any but large plants. (Miami, Fla., is building an 80-ton per day kiln for its 60 mgd softening plant.) Multiple-hearth furnaces have been used, but require an unusual amount of maintenance. Two calcining furnaces satisfactory for small plants have been developed, one by H. V. Pedersen in conjunction with the Raymond Pulverizer Division of Combustion Engineering Corp.; the other the "Fluo Solids" system developed by the Dorr Co. A 10-ton per day Pedersen plant is to be built by Marshalltown, Ia. A 60-ton Fluo Solids plant will be completed early in 1948.[A6]

Bibliography of Waterworks Literature

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December 25

1. What Filter Sizes Are Economical? By Harold A. Thomas, Jr. Pp. 52-53.
2. Submerged Weir Discharge Studies. By James R. Villemonte. Pp. 54-57.
3. Bromine for Swimming Pool Disinfection in Illinois. P. 69.

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4. Los Angeles Program Speeds Reconditioning of Cast-Iron Pipe. P. 92.
5. Water Supply Job Follows 1924 Plans. (Mokelumne aqueduct.) Pp. 96-98.
6. pH Scores May Be Standardized. P. 103.

F *Water Works Engineering*

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7. Reviving an Old Water Works. By M. H. Strong. Pp. 1476-1478, 1496.
8. Distribution System Flow Tests. By Angus D. Henderson. Pp. 1486-1487.

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9. Electronic Equipment as an Aid in Water Waste Surveys. By D. C. McFarlin. Pp. 1524-1526.

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5. Iron and Manganese Removal. By S. B. Applebaum. Pp. 439-448.
6. The Water Supply at Lagos, Nigeria. Pp. 452-453.

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4. Proper Handling of Joint Compound Speeds Pipe Line Construction. By R. A. Toler. Pp. 29-30.
5. Protecting Hydrants Against Traffic Damage. P. 36.

X *Journal of Public Health*

December

5. Methods of Removing Fluorides from Water. By F. J. Maier. Pp. 1559-1566.

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6. La Realimentation des Nappes Aquiferes. By R. Soyer. Pp. 58-69.
7. Barrages et Retenues Souterrains. By W. Guembel. Pp. 70-75.
8. L' Utilisation Rationnelle des Ressources Aquiferes Souterraines. By A. Achten. Pp. 76-78.
9. L' Exploitation des Eaux Souterraines dans le Couches Diluviales du Sud-Est de la France. By M. Wegenstein. Pp. 79-81.
10. La Recherche et la Detection des Fuites. By M. Pillot. Pp. 82-85.

Y *Contractors Record (England)*

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1. Service Reservoirs for Water Supplies. By L. E. Hunter. Pp. 13-17.

Z *Technique De L' Eau (Belgium)*

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3. L' Utilisation Rationnelle des Ressources Aquiferes Souterraines. By A. Achten. Pp. 17-22.

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Water Works Publications

Chemical Solution Feeders. — A 4-page folder, describing and giving specifications for the Type COE chemical solution feeder. Infilco, Inc., 325 West 25th Place, Chicago, Ill.

Conditioning Liquids. — A 60-page bulletin, a revision of a previous publication to include the most recent developments in the design of water treatment and liquid conditioning equipment. More than 35 illustrations, with tables and charts. Lists various impurities with effects, tolerance limits and methods of removal. Liquid Conditioning Corp., 114 East Price St., Linden, N. J. Ask for Bulletin G-1.

Indicating Controllers and Recorders. —A 16-page booklet designed to serve as a guide to the applicability and use of round-chart Micromax instruments for regulating or controlling valves, vanes, dampers or other equipment. Ask for Catalog ND44(2), Leeds & Northrup Co., 4934 Stenton Ave., Philadelphia 44, Pa.

Sika Seal is a protective coating claimed to have excellent adhesion to wet or dry surfaces; it can be applied under water to concrete, mortar, wood, steel or other metal or non-metal surfaces. Pamphlet A is designed for engineers and architects; Pamphlet I for contractors and maintenance engineers. Sent on request. Sika Chemical Corp., Passaic, N. J.

Float Switches.—These two folders describe: (1) The L200 float switch, 2-pole, double break, silver to silver contact, which is a completely packaged job, ready to install; ask for Bull. L3; (2) The type HR alternator specifically built for duplex pump installation to equalize the wear by frequent alternation of load; ask for Bull. 3150. Automatic Control Co., 1005 University Ave., St. Paul 4, Minn.

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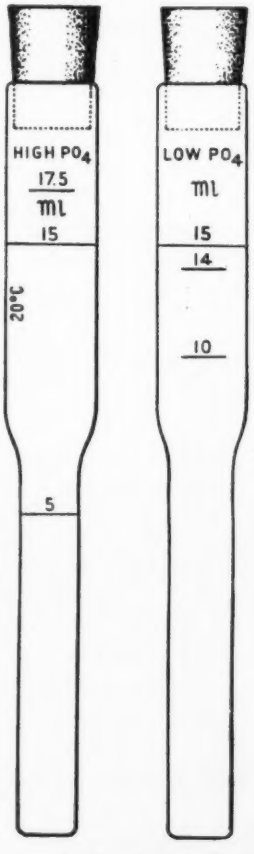

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Schied Bantam shovel with "moles paw."

A 1/3-yd. Shovel and Moles Paw

This is a truck-mounted, all-purpose light shovel, which is convertible to drag-line, clam, crane or trench hoe. It is mounted on any standard 1½-ton truck and is powered with an International or LeRoi engine. As a drag-line or shovel, under normal conditions, it is claimed to handle 50 to 60 yds. per hour; and as a trench hoe to dig 100 ft. of 5-ft. trench per hour. It will cut a trench 11 ft. below ground level. The "moles paw" bucket is especially adapted to trenching in sticky soil. Ask for Bulletin 747. *Schied Bantam Co., Inc., Waverly, Iowa.*

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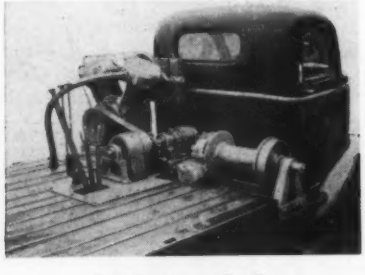
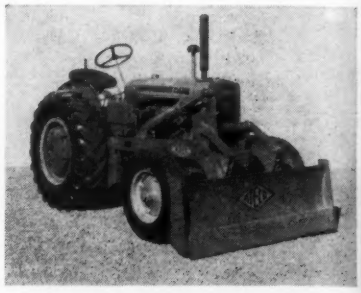
A heavy-duty power takeoff and a truck-mounted air compressor and winch assembly, which can be installed easily on a truck, provides a handy unit for lifting and laying water pipe, loading and setting hydrants, handling large sewer pipe, and doing all the other lifting work incidental to city and county engineering. The compressor delivers 105 cfm. at 100 lbs. The units takes up little room. Write *Truck Equipment Division, Davey Compressor Co., Kent, Ohio,* for information.



Davey power takeoff.

Bulldozers for Municipal and County Use

Here are three new bulldozers designed for use with Case industrial wheel tractors. These have many uses in municipalities and counties—backfilling, clean-up work, fast bulldozing, excavating around foundations, light stripping, aggregate handling and leveling. They cut the full width of the tractor, but the tractor front wheels will turn in their normal radius. *American Tractor Equipment Co., 9131 San Leandro Blvd., Oakland 3, Calif.*



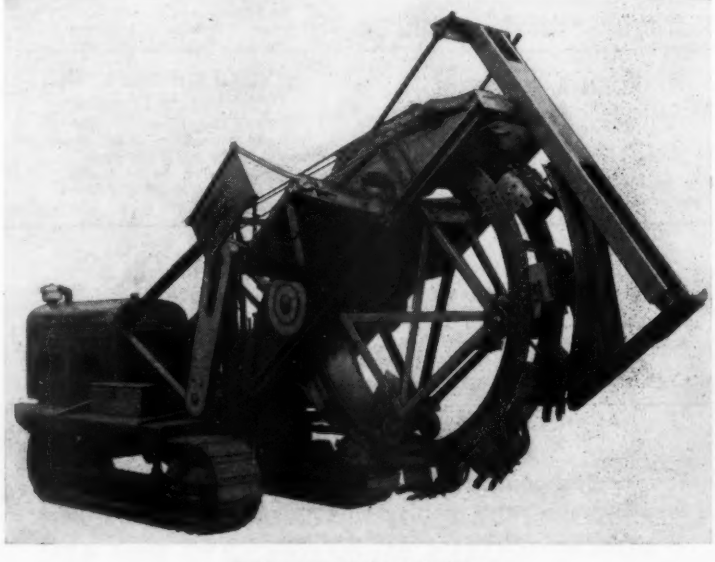
For light, fast bulldozing.

Buckeye Municipal Trench Digger

This new model cuts trenches 16" to 30" wide, depending on the buckets used, and to 6' deep. It is of the digging wheel type, and has digging speeds up to 57.5 feet per minute. It has a diesel engine of 67 hp. Speeds are four forward and four reverse. This is the Model 312. Full data from *Gar Wood Industries, Inc., Findlay Division, Findlay, Ohio.*

An Angling Blade Bulldozer for Small Jobs

This is an angling type, hydraulic controlled bulldozer designed exclusively

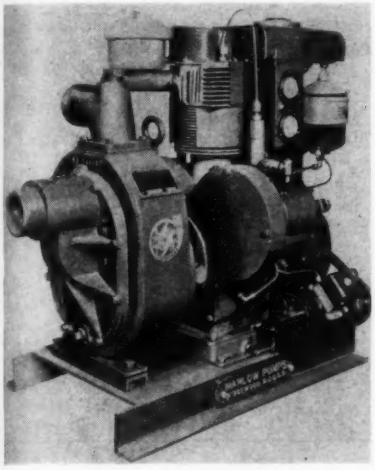


Buckeye municipal trench digger.

for the Caterpillar D4 crawler tractor. The blade will lift about 31 ins. above the ground; the maximum blade pitch adjustment is 25°, and the maximum tilting adjustment 6 ins. This unit is designed for small contracting work, cities and counties, snow removal, refuse handling, etc. *Caterpillar Tractor Co., Peoria, Ill.*

Developments in Small Centrifugal Pumps

Typical of four new lightweight, self-priming pumps recently introduced, is a 66-pound unit, which moves 6,000 gph. at 5-ft. suction lift and pumps up

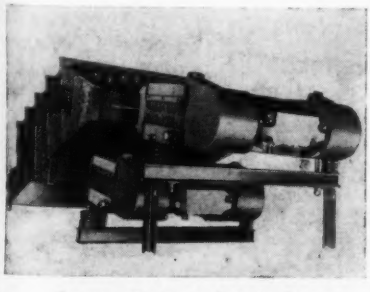


Marlow light centrifugal pump.

to 26,000 gallons on a single gallon of fuel. Others of the series range from 64 to 135 lbs. All have 4-cycle gasoline engines, but a larger pump is also available—220-gpm.— which utilizes a 3½-hp. Sheppard diesel and is said to pump 36,500 gallons of water with one gallon of fuel. Further data and folders: *Marlow Pumps, Ridgewood, N. J.*

Heavy Vibratory Grizzly

A large capacity heavy duty electric vibratory grizzly feeder for large capacity separation of crusher feeds, is the latest of these grizzlies announced by Syntron. These are single or double magnet, 220 or 440 volt AC in the larger models; 110 volt AC in the smaller. Full data from *Syntron Co., 660 Lexington Ave., Homer City, Pa.*



Syntron vibratory grizzly feeder.

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Belt Conveyors. — What you may want to know about belt conveyors is in this book; more important is the fact that in going through it you cannot help but learn something that will help you in your work, whether you are a contractor, a city or county engineer, a water works or sewerage engineer, or a highway engineer. 160 pages; lots of diagrams and tables. Ask for Catalog 785, Jeffrey Manufacturing Co., Columbus 16, Ohio.

Construction, Maintenance & Material Handling.—A 92-page catalog covering: (1) vibratory handling equipment—vibrators, vibratory feeders, dry feeder machines, weighing feeders, vibrating grizzlies, jolters, etc.; (2) construction and maintenance — self-contained gasoline hammer paving breakers, portable electric hammers, drills, form vibrators and flexible shaft concrete mass vibrators. Ask for it on your letter head. Syntron Co., Homer City, Pa.

Small Tractors.—A 4-page bulletin describes 2-wheel tractors with around 3-hp. engines, and small 4-wheel units weighing around 1000 to 1500 pounds, which are adaptable for many uses in city and county work. Shaw Mfg. Co., 1528 North 4th St., Columbus 8, Ohio.

Plastics & Rubber.—This is one of a series of 15 bulletins outlining forms of market research in the fields of chemistry and engineering. For a list of all bulletins, and specific information on any particular field, write Foster D. Snell, Inc., 29 West 15th St., New York 11, N. Y.

For Better Highways. — A new folder describes the Spray Master pressure distributor, road brooms, the Tankar heater, asphalt and tar supply tanks, and the Trail-O-Distributor, with helpful information on use. Littleford Bros., Inc., 452 E. Pearl St., Cincinnati 2, Ohio.

Material Handling. — Filled with engineering data, charts, tables and formulas to determine the best method of handling bulk materials, this Bulkflo Book, No. 2175, 48 pages, may answer many of your problems in material handling. Write Link-Belt Co., 2410 West 18th St., Chicago 8, Ill.

Diesel-Generator Sets.—An 8-page bulletin illustrating sets ranging from 175 to 1500 hp., super and non-super-charged, 6 and 8-cylinder. These are used in municipal power plants, public buildings, on construction, etc. Ask for Bull. 4709. Superior Engine Division, National Supply Co., Springfield, Ohio.

The Gurley Story

The sub-title is "A short story about a long career" and it tells the 102-year story of W. & L. E. Gurley, Troy, N. Y., makers of surveying instruments. It outlines in 16 pages the history of the company and gives illustrations of various instruments, taking the reader through 100 years of progress in instrument making. Send for it and enjoy reading it.

Beating a Power Shortage

To beat a hydraulic power shortage during the first half of 1948 in Caracas, Venezuela, two 1440-hp. turbo-supercharged Superior diesel engines were rushed to that city. The route was rail to New York, ship to La Guaira, and thence by road 23 miles to the plant site. These are the first of five engines to be installed.

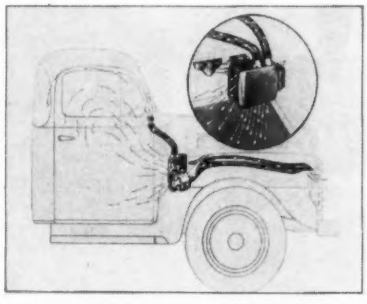
Huber Anniversaries

The Huber Mfg. Co., Marion, Ohio, is celebrating three anniversaries in 1948 — the 85th anniversary of the founding of the company by Edward Huber and Lewis Gunn; the 40th anniversary of the introduction of the Huber steam roller; and the 25th anniversary of the revolutionary "automotive type roller." In addition to the big new factory occupied in 1946. Huber will open a new foundry and a new bar stock building early this year.

The new Ford F-5, 1½-ton truck.

The New 1948 Ford Motor Trucks

THE 1948 Ford Motor trucks have been announced, with many improvements and in larger sizes. Ford trucks now include the following: A nominally rated half-ton series on a 114-inch wheelbase; three-quarter-ton regular and heavy duty models, with 122-inch wheelbase; one-ton, 134-inch wheelbase, models with single or dual tires; 1½-ton heavy duty series with 134- and 158-inch wheelbase; 1½-ton cab-over-engine heavy duty, with 110-, 134- and 158-inch wheelbase; 2-ton heavy duty with 134- and 158-inch wheelbase; 2-ton, heavy duty, COE; the extra-heavy-duty 2½-ton on 135-, 159- and 195-inch wheelbase; and bus chasses.



Ford cab ventilation and heating.

Two of these heavier trucks—the F-7 and the F8—are larger than any ever built before by Ford; they have gross maximum vehicle weights of 19,000 and 21,500 pounds. Three new engines are available—a 95-hp. 6-cylinder; a 100-hp. V-8; and a 145-hp. V-8.

These are the first completely new postwar product by Ford, and they represent attractive styling and many improvements for the owner and operator. Among the improvements listed by the manufacturer are: Greater front-end strength; heavier fenders, which are wider and give greater tire clearance; up to 7 inches greater width and more headroom in the cabs; a one-piece windshield with better visibility; a larger rear window; better weather-proofing for the cab; and improvements tending toward operator comfort, such as cushions, ash-tray, sun visor, and 3-way air control system. Steering ratios have been increased to provide easier handling. The light trucks have direct-action shock absorbers. The 2-ton and heavier models have vacuum power brakes.

The larger trucks have a 5-speed transmission. The F-7, with maximum gross vehicle weight of 19,000 pounds has a single speed hypoid heavy duty axle. The heavier F-8 has a 2-speed axle, making ten speeds available on this model.

Interior of Ford cab.

FOR THE ENGINEERS' LIBRARY

These helpful booklets are free to those actively engaged in engineering or construction. Mail coupon or write direct to addresses given, mentioning PUBLIC WORKS Magazine.

PW 2-48

Engineers' Library Dept., PUBLIC WORKS Magazine
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USE THIS COUPON

NEW LISTINGS

Have You a Deep Well Pumping Problem?

455. Peerless deep well pumps in a variety of types, with oil or water lubrication and any power drive, to pump water from any depth are subject of special bulletins. Write Peerless Pump Div., Food Machinery Corp., 301 W. Ave. at 26th St., Los Angeles 31, Calif.

Are You Looking for New Or Reconditioned Valves or Pumps

559. A 16 page bulletin listing all types and makes of new and reconditioned valves and pumps is now available on request from Sonken Galamba Corp., Second and Riverview, Kansas City, Kans.

Diesel Engines to Help You Build Profits

560. A new 28 page catalog just off the press titled "Superior Stationary Diesel Engines," is packed with facts that will help you build profits. For your copy write to Superior Engine Division, National Supply Company, Springfield, Ohio.

Need Low-Cost Air For Sewage Treatment?

602. New booklet on Centrifugal and Rotary Positive Blowers engineered to fit your needs: air for activated sludge; constant vacuum for filters; priming centrifugal pumps; measuring sludge gas; water treatment. Write Roots-Connersville Blower Corp., 712 Poplar Ave., Connersville, Ind.

Useful Attachments For Your Industrial Tractor

561. Need a front end bucket loader that can be converted into a light plow or grader in a matter of minutes? Write for this folder that illustrates, describes and gives specifications of the Ottawa Industrial Front End Loader for industrial tractors. Loads earth, sand, gravel and other bulk material. Quick change over can be made to light bulldozer, V-type snow plow, grader or maintainer with attachments. Write Dept. PW, Ottawa Steel Products, Inc., Ottawa, Kans.

For Completely Successful Trickling Filter Systems

562. There's a vitrified clay filter bottom block to fit every shape tank. These blocks can be laid quickly and easily by unskilled labor. For more information, full details, specifications and list of typical plants write any firm listed below: Metropolitan Paving Brick Co...Canton, O. National Fireproofing Corp. Pittsburgh 12, Pa. Ayer-McCarel-Reagan Clay Co..Brazil, Ind. Bowerston Shale Co.....Bowerston, Ohio

Complete Data on Digester Accessories and Sewage Gas Controls

563. Sewage gas controls, flame traps, waste gas burners, regulators, condensate and sediment traps and other equipment for utilizing and safe control of sewage gas are described and illustrated in catalog PWS-3. For copy of this catalog write to The Vapor Recovery Systems Co., 2820 No. Alameda Street, Compton, Calif.

You Need This Useful Pump Data

564. For complete data on sewage and trash pumps, both vertical and horizontal centrifugals for pumping sewage and sludge ask for bulletin PW 6202. For data on plunger type sludge pumps ask for bulletin 6300. For either or both write: Yeomans Bros. Co., 1409 N. Dayton St., Chicago 22, Ill.

How to Save Wood From Decay and Termites

565. If you have decay or termite problems or want to prevent them get the facts today by writing for ths 32-page biooklet telling all about Pentachlorophenol. Write to the Dow Chemical Company, Midland, Mich., asking for booklet No. PE 49.

Simple Method of Underground Pipe Installation

566. For bulletin on simple method of underground pipe installation for distances up to 150 or 200 feet by boring with the Hydrauger write to Hydrauger Corp., Ltd., 681 Market Street, San Francisco 5, Calif.

Portable Mixer for Any Cold Mix

567. For bulletin describing this portable mixer that will handle up to 3 cubic feet of any cold mix on an entirely new principle write to The Foote Company, Inc., 1954 State St., Nunda, N. Y.

Data on Steel Storage Tanks

568. Full information on steel storage tanks or elevated water tanks along with quotations are available on request. Send your specifications or request for additional information to Chicago Bridge & Iron Company, 332 So. Michigan Ave., Chicago, Ill.

New Versatile Power Grader

569. The Austin-Western 99-H power grader features all-wheel drive, all-wheel steer, high-lift blade, extreme reach and completely reversible blade. For folder describing, illustrating and giving specifications write to the Austin-Western Company, Aurora, Ill.

CONSTRUCTION AND MAINTENANCE

Save Money, Busting, Cutting, Digging, etc.

110. Powerful self-contained gasoline hammers illustrated in new booklet. Used as paving breakers and spike drivers. Easily portable, economical. Write Syntron Co., 660 Lexington, Homer City, Pa.

Methods of Installing Steel Sheet Piling

112. Illustrated descriptions of both standard and interlock corrugated steel sheet piling of minimum weight, maxi-

mum strength, ease of handling with methods of installation are contained in a booklet. If you have a job involving piling write Caine Steel Co., Dept. P.W., 1820 No. Central Ave., Chicago 39, Ill.

Reliable Every Purpose Pumps

117. New brochure by Gorman-Rupp Co., Mansfield, Ohio, illustrates and describes many of the pumps in their complete line. Covers heavy duty and standard duty self-priming centrifugals, jetting pumps, well point pumps, triplex road pumps and the lightweight pumps.

Mow Clean and Fast In Tight Corners

510. Send for latest literature about the Cunningham Mower for Fence Rows, Parking Areas, Driveways, Picnic Grounds and many other jobs. 3 ft. cut, variable speed, rugged, easy to handle. James Cunningham, Son & Co., Dept. 16, 13 Canal St., Rochester 8, N. Y.

Air Cooled Engines for Hundreds of Applications

524. Tested under severest conditions of long, hard use, these engines have earned world wide recognition as the "night" power for hundreds of applications. Get latest bulletin from Dept. PW, Briggs and Stratton Corp., Milwaukee 1, Wisc.

Data and Pictures of Complete Line of New Ford Trucks

532. Full line of new Ford Trucks for 95% of all hauling needs is pictured in colorful circular — Light Duty, One-Ton, Heavy-Duty and C. O. E. trucks. Also 48 out of over 100 standard, factory built chassis and body combinations. See before you buy. Write for your copy now. Truck and Fleet Sales Dept., Ford Motor Co., Dearborn, Mich.

Have You Floor Troubles?

550. Stonhard Company has the answers for rough, rutted concrete or wood floors. 48-page booklet tells all about how to resurface them without calling in outside help. Address: Stonhard Company, 883 Terminal Commerce Bldg., Phila. 8, Pa.

Power Mower for Water Works, Sewage Plants, Highways, Etc.

553. For cutting the grass around your Water and Sewage plants and removing weeds and tall brush along your highways the Jari power scythe is just the thing you need! For a booklet describing this mower which is said to be easy to handle, economical to operate, fast and clean around trees and can be handled by one man write Dept. PW, Jari Products, Inc., 2936-F Pillsbury Ave., Minneapolis 8, Minn.

Mechanical Testing Screen For Stone, Gravel, Slag, etc.

606. Gives fast, accurate sizing of test samples. The Gilson Testing Screen handles a large sample in three to five minutes. For bulletin giving complete details on this screen which has a size range from 4 inches to 200-mesh write Dept. P.W., Gilson Screen Co., Box 186, Mercer, Pa.

SNOW FIGHTING

For High-Speed Snow Removal

350. "Frink One-Way Sno-Plows" is a four page catalog illustrating and describing 5 models of One-Way Blade Type Sno-Plows for motor trucks from 1½ up to 8 tons capacity. Interchangeable with V Sno-Plow. Frink Sno-Plows, Inc., Clayton, 1000 Islands, N. Y.

STREETS AND HIGHWAYS

These Wheel Tractors Solve Many Hauling Problems

4. Specifications and full information about the new M-M wheel tractors in sizes 27 HP to 49 HP. Send for copies today. Dept. PW, Minneapolis-Moline Power Implement Co., Minneapolis, Minn.

Levels Sidewalks and Curbs Quickly and Easily

107. How the Mud-Jack Method for raising concrete curb, gutter, walls and streets solves problems of that kind quickly and economically without the usual cost of time-consuming reconstruction activities—a new bulletin by Koehring Company, 3026 W. Concordia Ave., Milwaukee 10, Wis.

Speed Your Work With These Powerful Motor Graders

128. Two powerful Galion motor graders designed to answer every requirement for more speed in road, airport, dam and housing construction work are fully described in a folder illustrated with many action pictures. Issued by Galion Iron Works & Mfg. Co., Galion, Ohio.

Strong, Speedy, Low-Cost Maintainer Has Many Uses

130. BG Maintainer, a powerful speedy, low-priced machine for light road maintenance. Full details in illustrated folder. Huber Mfg. Co., Dept. P.W., Marion, Ohio.

Mix-in Place Roadbuilders Save on Scarce Labor

187. Mix-in Place Roadbuilders. Bituminous Pavers, Concrete Bituminous Finishers. Adjustable Spreaders, Forms, etc. —4 complete catalogs in one cover, issued by the Jaeger Machine Company, 400 Dublin Ave., Columbus 16, Ohio.

Here's Your Diesel Tractor!

190. Big 48 page catalog describes and lists many uses for International Diesel Tractors. Write International Harvester Co., Dept. P.W., 180 North Michigan Ave., Chicago 1, Ill.

Latest Maintenance Equipment For Blacktop Roads

290. "Blacktop Road Maintenance and Construction Equipment" — Asphalt and

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tar kettles, flue type kettles, spray attachments, tool heaters, surface heaters, road brooms and rollers. This is modern and up-to-date equipment for blacktop airport and road construction and maintenance. Write for Catalog R. Littleford Bros., Inc., 452 East Pearl St., Cincinnati 2, Ohio.

Need Street, Sewer or Water Castings?

429. Street, sewer and water castings in various styles, sizes and weights. Manhole covers and steps, inlets and gratings, adjustable curb inlets, water meter covers, cistern and coal hole covers, gutter crossing plates, valve and lamphole covers, etc. Described in catalog PW issued by South Bend Foundry Co., South Bend 23, Ind.

Protect Your Grade Crossings With Model 10 Signals

548. Bulletin G15-PW12 describes and illustrates the automatically operated Model 10 railroad crossing signal. Folder describing this signal which guards against "second train" accidents and permits fast flow of rail and highway traffic is available on request from Western Railroad Supply Co., 2406-2436 South Ashland Ave., Chicago 8, Ill.

Save Time and Labor by Using a "Black-Topper"

554. The Etnyre "Black-Topper" is a bituminous distributor that will save you time and labor on the job. For bulletin giving details of the accurate, dependable and economical performance of this distributor write Dept. PW, E. D. Etnyre & Co., Oregon, Ill.

SEWAGE DISPOSAL

Non-Corrosive, Long Lasting Low Cost of Sewer Pipe

72. Get this new engineering data on clay pipe for sewers. Withstands acid, alkali and gas attacks indefinitely. Cuts maintenance costs to a minimum. Write Dept. P.W., National Clay Pipe Mfrs., 111 W. Washington St., Chicago 2, Ill.

How You Can Clean Sewers From Streets Easily and Inexpensively

386. 32-page illustrated booklet explains how a city can clean its sewers and culverts with its own forces using the up-to-date Flexible Sewer Rod equipment. Illustrates and describes all necessary equipment. Issued by Flexible Sewer Rod Equipment Co., 9059 Venice Boulevard, Los Angeles 34, Calif.

How Cities Can Do Complete Sewer Cleaning From Street

387. Literature illustrating how cities, towns and villages using OK Champion Sewer Cleaners are doing a complete sewer cleaning job from street level. Three sizes of machines available in addition to full line of sewer rods and accessories. Issued by Champion Corporation, 4752 Sheffield Avenue, Hammond, Indiana.

How to Select Main Line Meters

432. New bulletin illustrates Builders Air Relay system for liquids containing suspended solids like sewage. Eliminates corrosion, clogged pipes, etc. "The Selection of Main Line Meters," a highly informative and useful presentation, describes forms of differential producers and quickly solves typical problems with the use of graphic charts. Write Builders-Providence, Inc., Dept. P.W., 9 Codding St., Providence 1, R. I.

Concrete Pipe With Greater Elasticity

442. Lock Joint Reinforced Concrete Sewer Pipe, Pressure Pipe, Culvert Pipe. Centrifugal Pipe and Subaqueous Pipe is described and illustrated in bulletins available from Lock Joint Pipe Co., Ampere, N. J.

Save Trucks and Labor In City Rubbish Collection

459. For saving trucks, labor, and time in city rubbish collection get details of the new Dumpster-Kolector described in literature just published by Dempster Brothers, Inc., 996 Higgins, Knoxville 17, Tenn.

An Incinerator Necessity

463. Recuperator tubes made from Silicon Carbide and "Fireclay" Corebusters for maximum efficiency are described and illustrated in bulletin No. 11 issued by Fitch Recuperator Co., Dept. P.W., Plainfield National Bank Bldg., Plainfield, N. J.

How You Can Dispose Of Sewage Solids

464. Nichols Herreshoff incinerator for complete disposal of sewage solids and industrial wastes—a new booklet illustrates and explains how this Nichols incinerator works. Pictures recent installations. Write Dept. PW, Nichols Engineering and Research Corp., 60 Wall Tower, New York 5, N. Y.

Ask for This Design Data On Sprinkling Filters

469. Design data on sprinkling filters of Separate Nozzle Field and Common Nozzle Field design as well as complete data on single and twin dosing tanks, and the various siphons used in them, for apportioning sewage to nozzles. Many time-saving charts and tables. Write Pacific Flush Tank Co., Dept. P.W., 4241 Ravenswood Ave., Chicago 13, Ill.

How the Hydro-Treator Works

486. 28-page catalog describes and illustrates the Dorrco Hydro-Treator, a self-contained water treatment unit combining Flocculation, Sludge Thickening and Clarification. Reduces treatment time and lowers plant construction costs. The Dorr Co., Dept. P.W., 570 Lexington Ave., New York 22, N. Y.

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Packaged Sewage Treatment—Just Right for Small Places

488. "Packaged" Sewage Treatment Plants specifically developed for small communities — 100 to 3,000 population. Write for full description and actual operating data for this type of plant. Chicago Pump Co., 2348 Wolfram St., Chicago 18, Ill.

How to Stabilize Lime Softened Water

498. Engineering Bulletin describes stabilizing lime-softened water by recarbonation, discusses gas production, washing, compressing, drying, and applying the CO (2). Infilco, Inc., 325 West 25th Place, Chicago 16, Ill.

WATER WORKS

Hydraulic Pipeline Scraper For Water and Sewage Mains

382. For a copy of this compact folder on a hydraulic pipeline scraper which cleans all kinds of mains from 4 inches to 14 inches write to Dept. PW, Carver-Stimpson Pipe Cleaning Co., Walters, Okla.

Solve Corrosion Problems With This Special Alloy

391. "Everdur Metal" is title of an 8-page illustrated booklet describing advantages of this corrosion-resisting alloy for sewage treatment equipment, reservoir, and waterworks service. Dept. P.W., the American Brass Co., 25 Broadway, N. Y. C.

Chem-O-Feeders for Automatic Chemical Feeding

400. For chlorinating water supplies, sewage plants, swimming pools and feeding practically any chemical used in sanitation, treatment of water and sewage. Flow of water controls dosage of chemical; reagent feed is immediately adjustable. Starts and stops automatically. Literature from % Proportioneers, Inc. %, 96 Codding St., Providence 1, R. I.

Helpful Data on Hydrants

405. Specifications for standard AWWA fire hydrants with helpful instructions for ordering, installing, repairing, lengthening and using. Issued by M. & H. Valve & Fittings Co., Dept. P.W., Anniston, Ala.

Complete Data on Gates, Valves, Hydrants

414. Gate Valves. Double disc bronze mounted, sizes 2" to 72", hand, hydraulic, electric or pneumatic operating, rising or non-rising stem. Bulletin X. Address: Rensselaer Valve Co., Troy, N. Y.

88 Page Book Helps Solve Water Problems

423. pH and Chlorine Control. A discussion of pH control and description of comparators, chlorimeters and similar devices. An 88-page booklet. W. A. Taylor & Co., 7304 York Road, Baltimore 4, Md.

Quick Way to Locate Leaks and Pipe

426. Leak Locators. Again available to waterworks superintendents, the Globe line of leak locators, dipping needles and pipe finders. Several leaflets describing the original Geophone leak locator, Little Wonder pipe phone, and the Magnetite Dipping Needle. Globe Phone Mfg. Corp., Dept. P., Reading, Mass.

Cast Iron Pipe Handbook—Handy Pocket Size

436. Handbook of Universal Cast Iron Pipe and Fittings, pocket size. 104 pages, illustrated, including 14 pages of useful reference tables and data. Sent by The Central Foundry Co., Dept. P.W., 386 Fourth Ave., New York 16, N. Y.

Cast Iron Pipe and Fittings For Every Need

437. Cast iron pipe and fittings for water, gas, sewer and industrial service. Super-deLavaud centrifugally-cast and pit-cast pipe. Bell-and-spigot, U. S. Joint flanged or flexible joints can be furnished to suit requirements. Write U. S. Pipe and Foundry Co., Dept. P.W., Burlington, N. J.

Do You Have This Data On Cast Iron Pipe?

438. "Cast Iron Pipe and Fittings" is a well illustrated 44 page catalog giving full specifications for their complete line of Sand Spun Centrifugal Pipe, Fire Hydrants, Gate Valves, Special Castings, etc. Will be sent promptly by R. D. Wood Co., Dept. P.W., Public Ledger Building, Independence Square, Philadelphia 5, Pa.

Makes Underground Pipe Installations Easy

444. One-man-operated Hydraulic Pipe Pusher pushes pipe through ground under streets, sidewalks, lawns and other obstacles. Pays for itself in man hours saved on first few jobs. For complete facts and prices, ask for booklet S-117. Greenlee Tool Co., 2042 Columbia Ave., Rockford, Ill.

Interesting Facts About Transite Pipe

445. Two new illustrated booklets "Transite Pressure Pipe" and "Transite Sewer Pipe" deal with methods of cutting costs of installation and maintenance of pipe lines and summarize advantages resulting from use of Transite pipes. Sent promptly by Johns-Manville Corp., Dept. P.W., 22 East 40th St., New York 16, N. Y.

How to Make Better Sewer Pipe Joints

447. How to make a better sewer pipe joint of cement—tight, minimizing root intrusion, better alignment of joint. Permits

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making joints in water-bearing trenches. General instructions issued by L. A. Weston, Dept. P.W., Adams, Mass.

Need a Water-Tight Pipe Joint?

449. Full information on "Hydro-Tite" jointing compound for bell and spigot pipe, together with specifications, instructions; and illustrations both on it and "Fibrex" sanitary joint packing are contained in handsome 48-page booklet. Address: Hydraulic Development Corp., Dept. P.W., 50 Church St., New York.

Data on High Efficiency Well Water Systems

454. Installation views and sectional scenes on Layne Vertical Centrifugal and Vertical Turbine Pumps fully illustrated and including useful engineering data section. Layne Shutter Screens for Gravel Wall Wells. Write for descriptive booklet P.W., Adv. Dept., Layne & Bowler, Inc., Box 186, Hollywood Station, Memphis 8, Tenn.

Oil or Water Lubricated Turbine Pumps

456. Oil lubricated turbine pumps with open impellers. Five types of heads available. Specifications and illustrations in new bulletin 6930M-2 issued by Fairbanks, Morse & Co., Dept. P.W., 600 So. Michigan Ave., Chicago 5, Ill.

Are You Thinking About A Swimming Pool?

472. Data and complete information on swimming pool filters and recirculation plants; also on water filters and filtration equipment. For data, prices, plans, etc., write Roberts Filter Mfg. Co., 640 Columbia Ave., Darby, Pa.

Eliminate Taste and Odor From Your Water

474. Technical pub. No. P.W. 207 issued by Wallace & Tiernan Co., Inc., Newark 1, N. J., describes in detail taste and odor control of water with BREAK-POINT Chlorination. Sent free to any operator requesting it.

Outdoor Water Service Devices That Do Not Freeze

506. Data on anti-freeze outdoor drinking fountains, hydrants, street washers, etc., contained in Catalog L. Sent promptly on request to Murdock Mfg. & Supply Co., 426 Plum St., Cincinnati 2, Ohio.

Here's Data on All Swimming Pool Needs

508. Well illustrated bulletin describes Filters, Water Softeners, Hydrogen Ion Plants and Complete Equipment for Swimming pools, etc. Copy sent on request by Dept. PW., Chemical Equipment Co., 223 Center Street, Los Angeles 54, Calif.

Find Buried Pipe and Leaks

545. Finding Buried Pipe, Leaks is easy with the new Featherweight Goldak Pipe Locator. An easy-to-read illustrated bulletin tells the full story quickly. Address: The Goldak Co., 1544 W. Glenoaks Blvd., Glenade 1, Calif.

Tired of Digging at Random?

555. There's a better way to locate leaks or "lost" pipe, valves, etc. New literature showing latest models of Pipe Finders, Leak Locators, etc., is offered free by Fisher Research Laboratory Inc., 1961-65 University Ave., Palo Alto, Calif.

Water, Gas, Sewer Pipe Line Equipment

558. Joseph G. Pollard Co., Inc., 145 Ashland Place, Brooklyn, N. Y. Eastern Distributors for the Fisher M-Scope, has issued a catalog No. 24 which describes the mechanisms manufactured by the company for maintenance and construction of pipe lines, melting furnaces and torches, pouring pots, dippers, pails, derricks, tools, joint runners, pipe cutters, hydrant testers, thawers, sewer cleaning machines and similar equipment.

TO OBTAIN THESE BOOKLETS USE COUPON ON PAGE 77

New Jersey Sewage Works Assn.

The Thirty-Third Annual Meeting of the New Jersey Sewage Works Association will be held at the Stacy-Trent Hotel in Trenton, New Jersey, on March 10, 11 and 12, 1948.

Highway Transportation Congress

The Second Highway Transportation Congress will be held in Washington, D. C., May 6 and 7, 1948, with headquarters at the Mayflower Hotel.

New Jersey Section, AWWA

The fall meeting of this association will be held Nov. 4-6, 1948, at the Madison Hotel, Atlantic City, N. J. C. B. Tygert, PO Box 178, Newark 1, N. J., is secretary.

Personal News and Appointments

Burns & Kenerson, Inc., consulting engineers of Boston, Mass., have announced that Ivan A. Buchanan is now associated with them in charge of their sanitary engineering section.

Leslie Williams and Charles M. Upham, Jr., have established an advisory service to communities and companies on traffic and city planning, with offices at 292 Madison Ave., N. Y.

M. C. Buhl has been appointed Galion representative for the North Central States, and Rex Price for the Southwest. Y. T. Leftwich has retired from active duty but will act as Machinery Consultant to Galion and to Mr. Price. R. E. Forsythe has retired as Branch Manager at Harrisburg, Pa., and that office has been closed. However, Mr. Forsythe will continue to act as Machinery Consultant to Galion and to Allied Equipment Company.

Murray D. Shaffer, director of the Ohio Department of Highways has resigned that position to become Director of Sales and Research Consultant for Buffalo-Springfield Roller Co., Springfield, O. Mr. Shaffer has had a long experience as county engineer, consulting engineer and in the State Highway Department. Buffalo-Springfield also announce the appointment of the O. S. Stapley Co., Phoenix, Ariz., as exclusive distributor in that state.

L. S. Curfew has been made executive vice-president; Joseph F. Lee, general manager; and George F. Denny, chief engineer of Vapor Recovery Systems Co.

JOBS FOR ENGINEERS

California Department of Highways needs engineers. For men just out of college, pay is $268-325; for men with 2 years experience, pay is $325-395. Write J. G. Standley, Asst. State Highway Engineer, Public Works Bldg., Sacramento, Calif.

Young man, skilled in industrial waste disposal. Must be of unusual caliber. Location New York. Pay about $6,000. Write The Editor who will forward all letters.

Advertising Index